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The Engineer

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High Capacity Mineral Wagons.

PUBLIC NOTICES

The Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, REQUIRES :—
1. OIL TANK WAGONS (RAILWAY). Required for shipment by middle of February, 1924.
2. MILD STEEL BARS AND JOISTS.
3. MILD STEEL PLATES AND SHEETS, BLACK, AND GALVANISED, PLAIN, AND CORRUGATED.
4. IRON BARS FOR HORSFALL NUT-MAKING MACHINES.
Tenders due on the 30th October, 1923. Tender forms obtainable from above. 3777

Assistant Engineer REQUIRED for Railway Construction, NIGERIA, for two tours of 12 to 18 months' service, with possible extension. Salary £480 for first three years of service and then £510, rising to £780 a year by annual increments of £30, and thence to £920 by annual increments of £40. Outfit allowance of £60 on first appointment. Free quarters or an allowance in lieu. Free passages and liberal leave in England on full salary. Candidates, aged 25 to 40, must have had experience of railway construction, of timber pile driving and under-water work in connection with slipways, also concrete work generally, and more especially in bridges, piers, and arched culverts.
Apply at once in writing, stating age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/Nigeria 12,229. 3804

Temporary Executive ENGINEER (for Water Supply) REQUIRED by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT, for a tour of 20 to 30 months' service. Salary £800 a year inclusive. Free quarters and passages and liberal leave in England on full salary. Candidates, aged 32 to 45, must have had considerable experience in the preparation of water supply schemes and in their execution. Should preferably have served as Chief Assistant to the Waterworks Engineer of a large borough and be A.M.I.C.E. or A.M. Inst. M. and C. E.—Apply at once by letter, giving brief details of qualifications and experience and stating whether married or single, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting M/12,227. 3772

Bengal-Nagpur Railway Company, Limited.
The Directors are prepared to receive TENDERS for : 8000 YARDS OF WATERPROOF CANVAS.
Specification and form of Tender can be obtained at the Company's Offices, 182, Gresham House, Old Broad-street, London, E.C. 2, on or after 5th October, 1923.
A fee of 10s. will be charged for the specification, which is not returnable.
Tenders must be submitted not later than Noon on Tuesday, 16th October, 1923.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
S. C. VOLKERS, Secretary.
3761

TENDERS INVITED.

County of London Electric Supply Co., Ltd.
BARKING POWER STATION.
The County of London Electric Supply Co., Ltd., are prepared to receive TENDERS for the SUPPLY of CONDENSER TUBES for their Barking Power Station.
Specifications may be obtained by manufacturers from the offices of the Company on application to the undersigned on or after the 10th October, 1923.
Sealed Tenders, marked "Tenders for Condenser Tubes for Barking Power Station," are to be addressed to the Chairman and Managing Director and lodged at the registered offices of the Company by Noon on 30th October, 1923.
The Company do not bind themselves to accept the lowest or any Tender.
F. C. McQUOWN,
Manager and Secretary,
County of London Electric Supply Company, Ltd.
Moorgate-court, Moorgate-place, London, E.C. 2. 3779

Administrative County of LONDON.
NORTH WOOLWICH DRAINAGE.—NEW 14in. DIAMETER RISING MAIN.
The London County Council invites TENDERS for PROVIDING, LAYING, and FIXING about 1 1-8 MILES of DOUBLE LINE of CAST IRON SOCKET and SPIGOT PIPES, together with AIR VALVES, CONNECTION to existing WASH-OUT PIPES, &c., and the REMOVAL of the DOUBLE LINE of OLD 14in. MAINS, in the Boroughs of East Ham and Woolwich.
Persons desiring to submit Tenders may obtain the form of Tender, &c., on application to the Engineer, at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application and the contract documents may be inspected before the payment of the fee.
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after Twelve Noon on Tuesday, 30th October, 1923, will be considered.
The Council does not bind itself to accept the lowest or any Tender.
JAMES BIRD,
Clerk of the London County Council.
3806

East Indian Railway.
The Directors are prepared to receive up to Eleven o'clock a.m. on Wednesday, the 24th instant, TENDERS for the SUPPLY of :—
STEAM TRAVELLING CRANES.
Copies of the specification can be obtained at the Company's offices on payment of £1 1s. each. This fee will not be returned.
G. E. LILLIE, Secretary.
19/20, King William-street, London, E.C. 4, 11th October, 1923. 3818

Tenders are Required in Cairo, not later than Noon on the 31st December, 1923, by the Ministry of Public Works, Mechanical Department, for the SUPPLY of a STEAMER for the Upper White Nile Division. Specifications can be obtained from the INSPECTING ENGINEER, Egyptian and Sudan Governments, Queen Anne's Chambers, Westminster, S.W. 1, on payment of £1 1s. 3769

PUBLIC NOTICES

Bombay, Baroda, and Central India Railway Company.
The Directors are prepared to receive up to Noon on Friday, 2nd November, TENDERS for the SUPPLY of :
1. STEEL MATERIAL.
2. WHEELS AND AXLES FOR WAGONS.
Tenders must be made on forms, copies of which, with specification, can be obtained at these offices on payment of 20s. each, which will not be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
S. G. S. YOUNG, Secretary.
Offices : 91, Petty France, Westminster, S.W. 1, 10th October, 1923. 3815

TO STEEL BRIDGE ENGINEERING CONTRACTORS.

The County Council of the West Riding of Yorkshire invite DESIGNS and TENDERS for the complete CONSTRUCTION of a STEEL GIRDER ROAD BRIDGE of 150ft. clear span, with ABUTMENTS and TWO FLOOD OPENINGS, over the river Aire at Carlton, near Snaith.
Conditions under which Tenders are to be submitted, specification and site plans may be obtained at the office of the West Riding Surveyor, County Hall, Wakefield.
A deposit of £1 will be required, returnable only on receipt of a bona fide Design and Tender. Cheques, &c., must be made payable to the West Riding Treasurer and sent direct to him at the County Hall, Wakefield.
The County Council do not bind themselves to accept the lowest or any Tender.
Sealed Designs and Tenders, duly endorsed, to be delivered to the West Riding Surveyor not later than Ten o'clock on the morning of the 27th day of November, 1923.
FRANCIS ALVEY DARWIN,
Clerk of the West Riding County Council.
County Hall, Wakefield. 3780

TO CONTRACTORS.

The Urban District Council OF ROYTON.
SEWAGE WORKS EXTENSION.
The above Council invite TENDERS from contractors for ADDITIONS and ALTERATIONS to their SEWAGE TREATMENT WORKS at Streetbridge, Royton, near Oldham, Lancashire.
The intended works comprise :—
Alterations to existing Detritus Tanks, Settlement Tanks and Filter Beds.
The Construction of Detritus Tanks, Seven Percolating Filters, Humus Tanks, Humus and Sludge Drying Beds.
The Culverting of River Excavation and Levelling of Lands.
The Provision, Laying, and Jointing of Pipe Lines.
A copy of the specification and bill of quantities may be obtained from the Surveyor to the Council, Town Hall, Royton, or from the Engineer, Mr. G. Bertram Kershaw, M. Inst. C.E., 9, Victoria-street, Westminster, S.W. 1, upon deposit of cheque for £5 5s., which will be returned upon the receipt of a bona fide Tender.
Copies of the drawings may be seen at the offices of the Surveyor or at the office of the Engineer.
The works being a scheme approved for finding work for the unemployed, the successful tenderer will be required fully to observe the conditions governing the grant in this respect.
Tenders, endorsed "Sewage Works Extension," will be received up to Noon on Tuesday, the 23rd day of October, 1923.
(Signed) ELLIS HARRISON,
Clerk to the Council.
Town Hall, Royton. 3808

PUBLIC NOTICES

State Electricity Commission OF VICTORIA.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to
Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 24/1.—ALUMINIUM STEEL CORED CABLE AND ACCESSORIES.
CHARGE.—10s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £100 is to be lodged with Tender.
The specifications may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m., 3rd January, 1924.
R. LIDDELOW, Secretary.
State Electricity Commission of Victoria,
3789 Melbourne, Victoria, Australia.

State Electricity Commission OF VICTORIA.
TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.
Copies of Tender form and specification will be available upon application to
The Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.
SPECIFICATION No. 23/145.—4 ONLY 1000 K.V.A. SINGLE-PHASE TRANSFORMERS and SPARES.
CHARGE.—10s. for the first two copies of Tender form, conditions of contract and specification complete. This charge will be returned on receipt of a bona fide Tender. A third copy and any further copies will be supplied for the sum of 5s. each. This charge is not returnable.
PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is to be lodged with Tender.
The specification may be inspected at the above-mentioned office.
The Commission does not bind itself to accept the lowest or any Tender.
Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than Noon, 15th December, 1923.
R. LIDDELOW, Secretary.
State Electricity Commission of Victoria,
3790 Melbourne, Victoria, Australia.

The Great Indian Peninsula Railway Company, 48, Copthall-avenue, London, E.C. 2, invite TENDERS for :—

	Fee for Specification.
1. STEEL WORK FOR BRIDGES	10s.
2. SOLID DRAWN STEEL BOILER TUBES	7s. 6d.
3. STEEL TYRES FOR LOCOMOTIVE ENGINES AND TENDERS	7s. 6d.
4. POINTS AND CROSSINGS, &c.	10s.
5. ROLLED STEEL CHECK RAIL BARS AND FASTENINGS	5s.
6. EXPANDED METAL	5s.
7. WOOD HANDLES	2s. 6d.
8. LEATHER BELTING, &c.	7s. 6d.
9. CHINTZ, TURBANS, &c.	5s.

Tenders are due by 11 a.m. on 23rd October, 1923. Tender forms obtainable at above address. Fees not returnable. 3812

PUBLIC NOTICES

Madras and Southern Mahratta Railway Company, Limited.
An ASSISTANT ELECTRICAL ENGINEER is REQUIRED in January next on the Company's staff in India. Candidates must be of non-Asiatic descent, unmarried, not more than 30 years of age, and the qualifications asked for are as follows :—
A public school education, a thorough training, both technical and practical, in electrical engineering and possession of some approved engineering diploma.
The Company maintains a considerable portion of its own telegraph lines and manufactures and repairs its own telegraph and block instruments, telephones, &c., and a knowledge of the manufacture of such instruments and of line construction and maintenance would be a recommendation. This qualification might possibly be obtained by a candidate at his own expense before sailing.
STARTING SALARY.—According to age and qualifications, with a maximum of Rs. 935 per mensem, rising according to the rules in force.
TERMS.—Subject to a strict medical examination by the Company's Consulting Physician, a three years' agreement in the first instance, a first-class free passage to India and home again on satisfactory termination of agreement, which is extensible by mutual consent. Employees are required to subscribe one month's pay yearly to the Company's Provident Fund, and to those of over five years' service a bonus equal to their contribution is credited, both bonus and contributions accumulating at compound interest until retirement.
Applications should be made by letter only, giving details in chronological order, with dates, general and technical education and practical experience. Special forms of application, which must be returned by 29th October, 1923, will be sent to applicants who appear to have the necessary qualifications.
25, Buckingham Palace-road, S.W. 1. 3793

Madras and Southern Mahratta Railway Company, Limited.
An ASSISTANT ENGINEER is REQUIRED in the Way and Works Department.
Candidates must be of non-Asiatic descent, unmarried, not more than 27 years of age, and the qualifications required are as follows :—
A public school education, technical education at a recognised Engineering College, possession of a certificate of having passed the examination for the Associate Membership of the Institution of Civil Engineers, or of an exempting degree.
Preference will be given to candidates who have had one or two years' experience as Assistant Engineer with a Railway Company or a Contractor on Public Works.
STARTING SALARY.—According to age and qualifications, with a maximum of Rs. 675 per mensem, rising according to the rules in force.
TERMS.—Subject to a strict medical examination by the Company's Consulting Physician, a three years' agreement in the first instance, a first-class free passage to India and home again on satisfactory termination of agreement, which is extensible by mutual consent. Employees are required to subscribe one month's pay yearly to the Company's Provident Fund, and to those of over five years' service a bonus equal to their contribution is credited, both bonus and contributions accumulating at compound interest until retirement.
Applications should be made by letter only, giving details in chronological order, with dates, of general and technical education and practical experience. Special forms of application, which must be returned by 29th October, 1923, will be sent to applicants who appear to have the necessary qualifications.
25, Buckingham Palace-road, S.W. 1. 3794

St. Monica Home of Rest, BRISTOL.
ENGINEER-IN-CHARGE WANTED for Running and Maintaining a Private Electric Generating Plant and other appliances.—Particulars may be obtained from the TREASURER, Merchants' Hall, Bristol, to whom applications for the appointment should be made in writing not later than the first post on Saturday, the 20th October. 3762

The British Cast Iron Research Association.
APPOINTMENT OF DIRECTOR OF RESEARCH
The Council invite APPLICATIONS for the POST of DIRECTOR of RESEARCH of the Association at a commencing salary not exceeding £900 per annum, according to scientific attainments.
The duties of the Director will be to attend to the scientific and metallurgical engineering research work of the Association.
Forms of application can be obtained from the undersigned, which are to be returned on or before October 20th, 1923.
THOS. VICKERS, Secretary.
Central House, 75, New-street, Birmingham, September 21st, 1923. 3632

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PUBLIC NOTICES

The Commissioners for the PORT OF CALCUTTA.

APPLICATIONS are INVITED for ONE MECHANICAL ENGINEER and for THREE ASSISTANT EXECUTIVE ENGINEERS with the following qualifications :—

MECHANICAL ENGINEER.

Candidates must have had not less than 12 years' experience (preferably with contracting engineers) after completion of training. Preference will be given to men with experience and knowledge of dock machinery and equipment. Age 25-40. Salary Rupees 1200 per month, rising by Rupees 75 to Rupees 1350 per month. Three years' agreement.

ASSISTANT EXECUTIVE ENGINEERS.

Civil Engineers who have had technical education in engineering, are physically fit and energetic and who have had some experience in dock construction. Preference will be given to men who have passed the examination for Associate Membership of the Institution of Civil Engineers or hold an exempting degree. They should be unmarried. Age about 27 years. Salary Rupees 700 per month, rising by Rupees 50 per month to Rupees 800 per month. Three years' agreement.

Applications, with copies of testimonials, to be sent to the undersigned not later than 19th October, 1923.

J. ANGUS, M. Inst. C.E.,
Consulting Engineer and London Agent.
10, Prince's-street,
Westminster, S.W. 1. 3783

Wanted, Two Assistant Engineers

for work in connection with Sewage Disposal Works. The appointments are only temporary ones and are at the inclusive rate of £350 per annum.

Applications, stating age, previous experience, and enclosing copies of three recent testimonials, to be sent to the CITY ENGINEER, Town Hall, Manchester, on or before Saturday, October 20th, 1923. 3767

SITUATIONS OPEN

WANTED, GENERAL MANAGER, to Control Large Engineering Works Manufacturing Patented Specialties in connection with Boiler Plant; experience similar capacity essential. State fully qualifications and experience, also remuneration expected; highest references necessary.—Address, P8144, The Engineer Office. P8144 A

ENERGETIC MAN REQUIRED to Control Department Manufacturing Wire Netting, comprising about 200 men. Must be thoroughly practical engineer. Only men with successful record and of highest integrity will be considered. Applicants to state age, experience, and salary required to Box No. 399, W. S. Crawford, Ltd., 233, High Holborn, London, W.C. 1. 3792 A

EXPERIENCED ENGINEER WANTED, to Take Charge under agent of Large Sewerage Contract with sea outfall and house connections, South America. State experience and salary.—Address, P8151, The Engineer Office. P8151 A

GENERAL MANAGER WANTED for Engineering Firm in Aberdeen, producing Conveying and Elevating Plants, Grinding Machinery, &c., specialists in Gearing and all kinds of Pulleys, also Millwright Work. Applicants must be qualified engineers, experienced in all branches of the firm's manufactures and accustomed to negotiating commercial contracts.—Address, stating age, qualifications, experience, and salary expected, to WATT and CUMINE, Advocates, 8, Golden-square, Aberdeen. 3807 A

METALLURGICAL CHEMIST REQUIRED with modern knowledge of Iron and Brassfoundry Practice, Case-hardening and Heat Treatment. Applications are only invited from fully qualified men. State age, experience, and salary required.—DAVID BROWN and SONS (Huddfd.), Ltd., Park Works, Lockwood, Huddersfield. 3781 A

PRACTICAL REPAIRING MECHANIC WANTED, to Take Charge Contractors' Plant on large contract, Georgetown, British Guiana. State experience and salary.—Address, P8150, The Engineer Office. P8150 A

SMART JUNIOR MEASURING CLERK WANTED for Constructional Engineers' Office; must be quick, accurate, and have had experience in measuring steel quantities.—Address, stating age, experience, salary, &c., 3784, The Engineer Office. 3784 A

REPRESENTATIVE REQUIRED, with Established connection London district, to obtain Engineers' Repetition Work for Manufacturers. Good commission basis.—Address, P8132, The Engineer Office. P8132 A

RETIRED ARTIFICERS, R.N.—COMPANY, operating in East Africa, REQUIRES THREE ENGINEERS; one must be a specialist on Water-tube Boiler Repairs, one General Engineer with experience on Erection of Machinery, and one General Engineer with good knowledge of Oil Engines, about 40 H.P. Salary about £360 per annum, with one servant allowance and free quarters. Passage out and home. Three years' agreement.—Write, sending copies only of testimonials, which will not be returned, to "W. W." c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 3773 A

TWO ENGINEERS REQUIRED for East Africa; one must possess good knowledge of Oil Engines, about 40 H.P., and the other with experience on erection of Machinery. Ginnery experience preferred. Salary about £360 per annum, with one servant allowance and free quarters. Passage out and home. Three years' agreement.—Write, sending copies only of testimonials, which will not be returned, to "H. D." c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 3774 A

REQUIRED for East Africa, an ENGINEER with experience of Cable Ploughing. Three years' agreement, free quarters, and one servant allowance. Free passage out and home.—Write, sending copies only of testimonials, which will not be returned, stating salary required, to "D. M." c/o J. W. Vickers and Co., Ltd., 5, Nicholas-lane, E.C. 4. 3775 A

WORKS MANAGER WANTED for Large Bridge and Steel Constructional Works in North-East of England. Man of good education preferred, age about 35. Applications from men with suitable experience only will be considered.—Address, giving full particulars and salary required, 3814, The Engineer Office. 3814 A

WANTED, Competent DRAUGHTSMAN, Used to Elevators and Conveyors for Cement, Coal, &c.—Address, 3763, The Engineer Office. 3763 A

WANTED, DRAUGHTSMAN for Constructional Engineering in S.W. of London.—Address, stating age, salary, experience, qualifications, &c., P8150, The Engineer Office. P8150 A

WANTED, First-class DRAUGHTSMAN, Thoroughly accustomed to the designing of Jigs and Tools used in connection with Light Printing or similar Automatic Machines. None but live men need apply.—Address, stating wages required, 3817, The Engineer Office. 3817 A

WANTED, ONE or TWO SENIOR DRAUGHTSMEN, conversant with Endless Track Vehicles or Heavy Motor Chassis. Knowledge of engine design not essential. London district. State age, experience, and salary required.—Address, 3816, The Engineer Office. 3816 A

DRAUGHTSMAN REQUIRED, Thoroughly Experienced in Gasholder Construction.—Address, stating age, salary, training, &c., 3778, The Engineer Office. 3778 A

SITUATIONS OPEN (continued)

DRAUGHTSMAN, Thoroughly Experienced in design of Steel Buildings and other Light Structural Work.—Apply by letter only, stating age, experience, and where enlisted, also salary required, to A. and J. MAIN CO., Ltd., Australia House, Strand, London, W.C. 2. 3768 A

DRAUGHTSMAN WANTED, Accustomed to Coal Screening and Colliery Surface Plants. State age, experience, salary required, and when at liberty.—Address, 3820, The Engineer Office. 3820 A

DRAUGHTSMAN WANTED IMMEDIATELY: Man with experience of Mechanical Chain-grate Stokers, previous experience essential.—Address, stating age and salary required, 3803, The Engineer Office. 3803 A

DRAUGHTSMAN WANTED, with Good Experience in the design of Printing Machinery. State experience, technical qualifications, age, and salary required.—Address, 3815, The Engineer Office. 3815 A

SENIOR DRAUGHTSMAN REQUIRED, with Up-to-date experience in the design of Uniflow and Heat Extraction Steam Engines, by Lancashire Firm.—Address, stating age, experience, and salary, 3785, The Engineer Office. 3785 A

SENIOR DRAUGHTSMAN, with Good General engineering experience and preferably with knowledge of Motor Tractor or Commercial Vehicle Design. £5 per week. State age and experience. Appointment temporary, but may be permanent.—Apply by letter only to CHIEF DRAUGHTSMAN, BARFORD and PERKINS, Ltd., Peterborough. 3764 A

SHIP DRAUGHTSMAN (HEAD) WANTED by Shipbuilder in Shanghai, aged 35 to 40. Must have held similar position before. Salary commencing £540.—Address, detailing experience, P8158, The Engineer Office. P8158 A

ERECTOR for Mechanical Chain-grate Stokers: Previous experience essential. Apply, stating age, experience, and salary required. Preference given to man with knowledge of Combustion conditions.—Address, 3802, The Engineer Office. 3802 A

SENIOR ESTIMATING CLERK REQUIRED, to Take Charge of Department; must be acquainted with Steam Pipe Installations for power stations, &c., and be able to supervise taking out quantities and pricing estimates. State age, experience, and salary expected.—Address, 3809, The Engineer Office. 3809 A

SITUATIONS WANTED

A. M.I.C.E., A.M.I. Mech. E., Aged 33 Years, SEEKS progressive POST. Will specialise in any branch of engineering. Thorough knowledge of foundry work and general engineering, good draughtsman and estimator, used to works administration and accounts. Will accept £6 per week for good prospects.—Address, P8153, The Engineer Office. P8153 B

A. M.I.M.E. REQUIRES POST, Either in Works or offices; many years' experience as works manager of leading railway carriage and wagon works; fluent Spanish scholar.—Address, P8109, The Engineer Office. P8100 B

AN Experienced ENGINEER SEEKS SITUATION; good draughtsman, used to overhead conveying systems, interviewing, measuring up, &c.; excellent refs.—NEWTON, 5, Grosvenor-road, Ilford. P8099 B

APPOINTMENT DESIRED by ENGINEER, 28, (Millwright); French linguist, drawing-office, general factory maintenance, oil fuel. Now in foreign sales and publicity department of firm of agricultural engineers.—Address, P8121, The Engineer Office. P8121 B

B.SC. (Honours), London Univ., in Mechanical and civil eng., 4 yrs. tech. training, SEEKS POST as Assistant or Apprentice, home or abroad; age 21 years; good testimonials.—Address, P8161, The Engineer Office. P8161 B

CHIEF CHEMIST DESIRES POSITION; 24 Years in steel and motor works, sound experience ferrous and non-ferrous analysis, heat treatment and metallography.—Address, P8070, The Engineer Office. P8070 B

CIVIL ENGINEER (30), A.M. Inst. C.E., A.R.I.B.A., water, sewage disposal, roads, bridges, buildings, REQUIRES POST with view to partnership; capital available.—Address, P8139, The Engineer Office. P8139 B

CIVIL ENGINEER, Age 39, Member Inst. M. and Cy. E., 18 years' Indian experience, roads, bridges, buildings, unable to live on furlough pay, WISHES TEMPORARY EMPLOYMENT, home or abroad, anywhere. Could represent buyers or manufacturers; well known Calcutta and industrial areas; able to secure business. Highest references, moderate salary and expenses.—Address, P8109, The Engineer Office. P8109 B

SITUATIONS WANTED (continued)

ENGINEER (37), A.M.I. Mech. E., with Practical and D.O. exp., leading firms in hydraulic and general eng., gas and oil engines, 6 years chief D.O., present position 5 years, works management, I.C. engines and automobiles, capable organiser, DESIRES NEGOTIATE NEW POSITION offering scope, or as London Representative.—Address, P8141, The Engineer Office. P8141 B

ENGINEER SALESMAN, Sound London Connection, gasworks, iron and steel and export merchants-engineers, would REPRESENT on commission.—Address, P8136, The Engineer Office. P8136 B

ENGINEER, Young, with Training in all Shops and drawing-office, thorough technical knowledge of steam, heat, internal combustion and gas engines, REQUIRES POST at home or abroad.—Address, P8137, The Engineer Office. P8137 B

FIRST-CLASS PRACTICAL ENGINEER, 25 Years' loco. experience, able to take charge all branches, also general maintenance, &c., exp., age 45, SEEKS POST.—Address, P8145, The Engineer Office. P8145 B

G.I.A.E., A.M.I. Mech. E. Exam. (24), SEEKS Progressive POSITION, works or experimental; University Diploma, Advanced National Diploma; first-class references.—Address, P8142, The Engineer Office. P8142 B

MECHANICAL and ELECTRICAL ENGINEER, with extensive experience in the East of locomotives, rolling stock and general engineering, DESIRES APPOINTMENT as AGENT or REPRESENTATIVE. Seven years' experience of electric light and power plants, A.C. and D.C.; accustomed to position of authority and responsibility; knowledge of French and Arabic.—Address, P8163, The Engineer Office. P8163 B

MECHANICAL ENGINEER (23), B.Sc. (Hons.), 4 years' shops and D.O. experience, 3 years' technical training, DESIRES POST at home or abroad. Highest references.—Address, P8148, The Engineer Office. P8148 B

RAILWAYS, LIGHT, HEAVY.—ADVERTISER (37), wide experience, manufacture, consulting, design, &c., WANTS POST any capacity; used to control, accustomed home, colonial and foreign works.—Address, P8110, The Engineer Office. P8110 B

STRUCTURAL ENGINEER (28) SEEKS POSITION, any capacity; works, D.O., and estimating exp. on light structural work and radio towers. Excellent technical education.—Address, P8140, The Engineer Office. P8140 B

STRUCTURAL STEEL WORK ENGINEER (40), Westminster representative, DESIRES CHANGE with more scope for improvement.—Address, P8162, The Engineer Office. P8162 B

DRAUGHTSMAN (Mechanical), Wide Experience in design and lay-out of various industrial plants, power station design, general engineering, DESIRES SITUATION.—Address, P8143, The Engineer Office. P8143 B

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For continuation of Small Advertisements see page 3.

A Seven-Day Journal

Assisted Research Workers and Students.

In the annual report issued by the Committee for Scientific and Industrial Research, a summary of the contents of which appears elsewhere in this number, a table, as usual, is given showing how the personal grants to research workers and maintenance allowances to promising post-graduate students were distributed during the year among the various sciences. As on previous occasions, we notice that the distribution is very inequitable. Taking both kinds of grant together, we find that chemistry easily heads the list with 156 individual allowances, biology comes second with 46, physics third with 36, engineering fourth with 24, and metallurgy fifth with 14. Under mathematics and astronomy, six cases of assistance are tabulated; under geology and mineralogy, five; and under aeronautics, three. The disproportion may be more apparent than real, for while biology may cover such important subjects as the study of tropical diseases, much of the work under physics and metallurgy may be of considerable engineering interest and value. On the other hand, there can be no doubt that the figure for chemistry is, relatively, excessive. The Committee itself comments upon it. It points out that there is to-day a considerable volume of unemployment among chemists, and that the number of graduates in chemistry has recently been so large that many of them cannot expect to find satisfactory scientific employment in the near future. As a consequence, the Committee, we notice, proposes to restrict the number of awards made to post-graduate students of chemistry, but, it is added, it would be glad to increase the number to students of biology and physics.

High Tensile Steel in Aircraft.

In a "notice to ground engineers," issued by the Air Ministry, we observe that the use of high-tensile steel fork ends for aeroplane stay wires is now prohibited, as such ends have been found unsafe. They are to be replaced by mild steel fork ends, and no certificate of airworthiness is to be issued until such replacement has been effected. On civil aircraft the use of high-tensile steel turnbuckles is still permitted, but it is evident that here, too, it might be desirable to replace such parts with corresponding details made of mild steel. It is stated in the notice that the high-tensile steel turnbuckles commonly in use are all of wartime manufacture, and are liable to exhibit fine hair cracks and flaws in the steel ends and season cracking in the barrels. In the case of seaplanes, turnbuckles with delta metal barrels are recommended instead of those fitted with mild steel barrels, the object being to obviate rusting.

The Trent Navigation Scheme.

On Tuesday Sir Montagu Barlow, the Minister of Labour, opened at Stoke Bardolph the second completed lock in the series which is to result in the deepening of the river Trent to an extent that will permit the passage from the sea of 120-ton barges at all seasons of the year as far up as Nottingham. Two more locks have yet to be completed. The scheme was begun two years ago, and, it is expected, will be finished by the end of next year. Its total cost will be about £200,000. Between Newark and Nottingham the Trent at present is practicably unnavigable in the summer, and only for a few months in the year can a barge of 100 tons secure a passage. In anticipation of the great improvement to be effected by the scheme, new works are already being established on the banks of the river, and one of the large oil companies is erecting storage reservoirs adjacent to it. The distance to be canalised is 96 miles, and at each of the four locks there will be a fall of 5ft. The work is being carried out almost entirely by ex-Service men, and affords an excellent example of how a scheme designed for the relief of unemployment can be made to give the promise of a full return in the future for the money expended upon it.

The Electricity Commissioners' Report.

The third annual report of the Electricity Commissioners issued on Friday of last week records an improvement in the electricity supply industry, but indicates that much further leeway has still to be made up before it can be regarded as operating on a normal basis. There are now in Great Britain 544 authorised undertakers holding statutory powers for the supply of electricity. Of that number, 324 are local authorities, 212 are companies, and 8 are individual persons. These figures indicate an increase of 10 in the number of authorised undertakers during the year. Efforts are now being made to compile a complete record of undertakings giving public supplies of electricity for lighting and other purposes which have been established without statutory powers. At the same time, a list of private undertakings serving industrial purposes has been secured, so that it may be possible to prepare a census of the generating plant installed or in operation in Great Britain. Such a census, it is thought, would constitute a valuable asset in dealing with the question of the reorganisation of electricity supply and of the potential demands for industrial purposes in the event of public supplies being made available at sufficiently favourable rates. In the course of some general observations on the progress made in the establishment of electricity districts, the Commissioners comment on the immense scope for the further development of public supplies of electricity which their investigations have revealed. Taking twelve of the established or proposed districts responsible for over 50 per cent. of the total public supply at present generated in Great Britain, they state that the aggregate increase in the units produced within the next ten years is estimated conservatively at 180 per cent.

The Littleton Pumping Station.

Definite progress is now being made with the erection of the pumping station at the Metropolitan Water Board's huge new reservoir at Littleton, near Staines. The contract for the brick and stone work of the building has just been awarded to John Laing and Son, of London and Carlisle. The building will cover an area of more than 20,000 square feet. Included in Messrs. Laing's contract is the erection of a hexagoned sectioned chimney, 150ft. high. The building will house four large centrifugal pumps, which will draw water from the Thames through 5ft. diameter pipes and deliver it into the reservoir against a head of 40ft. The boiler-house is to contain five boilers supplied with coal from reinforced concrete bunkers, each having a capacity of 120 tons.

An Armour Plate Rumour.

A London newspaper a few days ago, with a glibness characteristic of the daily Press when dealing with technical matters, published what it called a "sensational rumour" regarding a discovery that would enable armour plates to be made of one-third the weight and with ten times the resistance to penetration of those made to-day. Progress in the improvement of armour plate is no doubt being made, although under present conditions it must be exceedingly slow. The step in advance indicated by the rumour would, if it could be realised, be something more than sensational, for it would open up an entirely new phase in naval design—to say nothing of effectively silencing Sir Percy Scott. On the face of it, however, the rumour is absurd, and it was hardly worth the while of a Sheffield contemporary to seek authoritative denial of it among the armour-plate makers of that city. As one of these manufacturers is reported to have said, even a 10 per cent. increase in the resistance to penetration would constitute a wonderful achievement.

The Boilermakers' Dispute.

A pause has ensued upon the activity reported last week in connection with the efforts made to settle the boilermakers' dispute. The Trades Union Congress representatives continue to discuss the situation informally with the parties concerned, including the employers, but as the negotiations are stated to be exceedingly delicate, it has not been found desirable to issue a report regarding the progress made. Everything would appear to hang upon the national conference of branch representatives of the Boilermakers' Society, which is to be held shortly. Meanwhile, it would appear that there is a growing recognition by the workers of the fact that the settlement of the dispute is a task to be effected primarily among themselves.

St. James's Park Lake.

An announcement in the newspapers regarding the existence of leakage in the lake in St. James's Park, London, the reconditioning of which by H.M. Office of Works was recently described in our columns, led us to inquire in official quarters whether it was really true that the source of the loss had been found "to be limited to 2 square inches approximately." The truth turns out to be that the loss amounted to 90,000 or 100,000 gallons of water per twenty-four hours, equivalent to the flow through an orifice of 2 square inches in area under a corresponding head. The leakage is believed to be almost certainly caused by the fact that the expansion joints of clay have not yet completely taken up their final state.

The Light Aeroplane Competitions.

On Monday a series of competitions for light aeroplanes begun at Lympne, Kent. Four prizes, totalling £2150, were offered by different individuals or bodies for different competitions. In one instance, the criterion was the greatest distance flown on a gallon of petrol. In another it was the same, except that the competition was restricted to British pilots flying British machines. In the third, the prize offered was to go to the machine fitted with an engine having a capacity not exceeding 750 c.c. which attained the greatest speed. In the fourth case, the prize was set for the greatest number of circuits flown, subject to a minimum of 400 miles. The course was a triangular one covering 12½ miles. No fewer than twenty-eight machines were entered for the contests. The machines taking part in the competitions are not, of course, of the glider pattern such as those which assembled for the trials at Itford Hill last autumn. They may best be described as glider type machines fitted with engines of motor cycle size. Whither the evolution of the light aeroplane is likely to lead us, we cannot clearly discern; but it is certain that the performances already achieved on it are in their way remarkable. Thus, on Monday one machine flew 87.5 miles on a gallon of petrol, another made twenty-four circuits of the course, and a third, with an engine not exceeding 15 horse-power in output, developed a speed of 66½ miles an hour.

Profit-Sharing in the Engineering Trades.

Interesting figures are given in the September issue of the *Ministry of Labour Gazette* as to the position of profit-sharing and co-partnership schemes in the engineering, shipbuilding and metal trades during 1922. The economic disturbances of the year, of course, left their mark on the results, for in the cases of the twelve firms concerning which details are given, 7665 workpeople received an average dividend of only £1 10s. 10d., representing an average ratio of bonus to earnings of 1 per cent. In the chemical, soap, oil and paint industries, 18,148 employees, in nine firms, participated in profit-sharing schemes, and received £10 9s. 9d. per head, or an average ratio of bonus to wages of 2.8 per cent. Altogether, throughout the United Kingdom, 154 firms, engaged in various trades and industries, distributed to 105,024 employees an average of £6 16s. 9d., or a bonus of 4.1 per cent. on earnings. During the year six new schemes were known by the Ministry to have been brought into operation. One of them was introduced by a firm of metal and ore merchants, employing ninety workpeople. The scheme consisted of a bonus in cash, payable on the salaries or wages of the staff at the same rate as the dividend paid to shareholders. To these figures, which apply to ordinary commercial concerns, may be added details of three co-operative production societies in the metal trades practising profit-sharing. According to the Labour Co-partnership Association's journal, one of these societies had a capital of £32,259, and with a turnover of £60,980, a profit of £3463 was made, £1375 being distributed at the rate of 1s. in the pound on wages. The other two societies had a combined capital of £4892, and although together they had a turnover of £20,780, only one made a profit—£15—and no dividend was paid.

Sudan Government Railways.

The *Railway Gazette* is responsible for the announcement that Mr. Felix J. C. Pole, the general manager of the Great Western Railway, has been invited by the Sudan Government to inspect its railway, harbour and steamer services and to report on possible economies in their administration, and working and as to whether the facilities are adequate to enable the resources of the country to be developed on economic lines. The first section of the Sudan railways to be opened was from Suakin on the Red Sea, with a branch from Port Sudan, to Atbara on the Nile, a distance of 326 miles. Then came the line from Halfa, at the second cataract, to Khartoum, 597 miles, and hence, *viâ* Sennar on the Blue Nile, to El Obeid, 438 miles. At Halfa connection is made with the steamers of the Egyptian State Railways from Assuan and the first cataract. The Sudan Government has its own steamers over the White Nile from Khartoum to Rejaf, 1100 miles. The latest returns show that the Sudan Railways had a mileage of 1500 of 3ft. 6in. gauge, which was worked by 114 locomotives, 228 passenger vehicles and 1000 goods wagons. In its river service there are 32 steamers.

Automatic Telephones on Railways.

From the paper on "Automatic Telephone Switchboards," read by Mr. W. J. Thorrowgood, signal and telegraph superintendent, Southern Railway, at the Institution of Railway Signal Engineers, we learn that when it was found necessary to increase the switchboard facilities at Waterloo, it was proposed to extend the four-position manual switchboard to a six-position, and to provide at least three additional operators. Instead of doing so, however, a 50-line automatic switchboard—capable of extension to 200-lines—was installed, which required no operators. The cost of the latter equipment was £1430, which, although £232 more than the proposed extension, was quite justified in view of the consequent savings in operation. At Southampton a 300-line automatic switchboard and a 100-line mechanical example have been fixed, whilst at Eastleigh there are a 100-line automatic and a 50-line manual. These switchboards serve the Southampton and Eastleigh area, and are connected with the switchboards at Waterloo. Another consequent saving is in the telegraph instruments and wires. These details have been removed in the Southampton area, as had already been done between Waterloo, Reading, Windsor, Farnborough, &c. At Southampton the automatic switchboard is connected to vessels in the docks, allowing for communication immediately a boat arrives, and up to the last moment before sailing.

Science and Industry in America.

By WALTER ROSENHAIN, D.Sc., F.R.S.

No. V.*

ELECTRICAL INDUSTRIES (*continued*).

MENTION of the activities of the General Electric Company and its subsidiaries in Cleveland leads naturally to Nela Park, the factory laboratory originated by the National Electric Lamp Association (N.E.L.A.) and continued as a separate research organisation after the absorption of that Association by the G.E.C. in spite of the great research laboratories of the that company at Schenectady. Nela Park is well known as in many ways an entirely model manufacturing establishment. The great groups of buildings situated on a hilly site in park-like surroundings suggest an academic institution rather than works. That industrial production can be carried out in conditions compatible with the amenities of life is clearly demonstrated here. Unfortunately, although the invitation to visit the laboratories and plant at Nela Park was given at least as warmly as elsewhere, circumstances did not permit the writer to obtain more than the most general impression of this great establishment; but that impression was undeniably that the whole establishment represents one of the most systematic attempts yet made to apply scientific methods and results to all the details of industrial practice.

No account of the work of the General Electric Company of America would be even rudimentarily complete without reference to an achievement which is regarded with considerable pride, the production of an electric transformer capable of producing a pressure of one million volts. This has actually been achieved in an experimental set erected at the Pittsfield plant of the company, but at the time of the writer's visit it had not yet been found possible to apply this enormous voltage to a vacuum tube. It is, of course, almost certain that this will soon be achieved, and the results may be looked to with considerable interest. It was thought at one time that the use of so high a voltage would make it possible to give to the electrons discharged from the cathode a velocity high enough to enable them to penetrate into the atoms exposed to their impact and that this penetration might lead to either disintegration or accretion in the atomic nucleus itself. More recent views developed by Sir Ernest Rutherford, however, do not lend so great an importance to the production of very high-velocity electrons. None the less, the results of bombardment with electrons under such immense power will be looked for with great interest.

The other great electrical research laboratory which the writer had an opportunity of visiting—that of the Western Electric Company at New York City—presents in many ways a striking contrast to that of the G.E.C. at Schenectady. Situated in the heart of a great city and far removed from the works of the same company, it forms a more completely self-contained unit and its equipment and *personnel* are arranged accordingly; there is a much larger proportion of what might be termed experimental production, dealing with that difficult stage which must necessarily intervene between a research or laboratory achievement and actual works production or application. The very large number of employees at the Western Electric Laboratory—it runs to something over 3000—therefore not only includes a large number of persons engaged on purely clerical and administrative work, but also those engaged in the workshops on what cannot be properly termed research, however necessary it may be to the application of research to industrial purposes. It may be, indeed, that it is attention to this oft neglected stage of development work, which is the real secret of the great success achieved by these large scientific industrial organisations. Beyond this, however, the whole trend and spirit of the Western Electric Laboratories appears to be of a more directly practical nature. A considerable amount of purely scientific work is carried out, as, for example, the work of McKeehan on the X-ray analysis of metals and alloys; but work of this kind seems to be regarded rather as a permissible luxury than as one of the true functions of the establishment, a viewpoint which is widely different from the very broad and far-seeing spirit at Schenectady. Perhaps it is this difference of attitude which accounts for the fact that the outside scientific world is not so familiar with the names of the leading men at the Western Electric Laboratory as it is with those of the other institution. Possibly the company itself may view such a difference with equanimity, since it may well claim that the acquisition of scientific fame by its staff is not one of its business objectives. None the less, this must be an important factor in determining the calibre of its staff, since financial returns alone cannot always attract men to whom the advancement of science along the lines in which they are keenly interested makes a great appeal.

From whatever standpoint, however, their work may be regarded, Dr. Arnold and his staff at the Western Electric Laboratory have some very notable achievements to their credit. Perhaps one of the most remarkable of these is the new magnetic alloy known as "permalloy," to which reference has already been made in the English technical Press. This is an alloy of nickel and iron, as free as possible from all other substances, containing 78½ per cent. of nickel and 21½ per cent. of iron. It has the property of being extremely sensitive to low magnetising forces, i.e., it has a very high magnetic permeability for low fields. The principal uses to which it is intended to put it is as an inductive loading for telegraph and telephone cables, to which it is applied by wrapping it directly upon the copper conductor. The very process of wrapping, however, subjects the strip of alloy to plastic strain sufficient to destroy its remarkable magnetic properties, and the whole conductor, after wrapping, must be carefully annealed before the insulation is placed upon it. This extreme sensitiveness to mechanical deformation may prove a serious disadvantage in practice, since it will not be easy to protect a cable—say, a submarine cable during laying—entirely from plastic deformation. None the less, the discovery of this alloy and its remarkable properties is a most interesting research achievement, particularly as even the most carefully established equilibrium diagram shows nothing to indicate the existence of special magnetic or other properties in the composition named. Actually, the alloy is being produced on an "experimental plant" scale in the laboratory under discussion. The means used are particularly interesting, as the metal is melted in very small quantities—8 lb. to 10 lb. at a time—in a crucible of vitreous silica in a Northrupp high-frequency furnace. Each melt occupies only a few minutes and the product is a single ingot, which is swaged and rolled hot and afterwards cold-rolled into thin strip, all by means of appliances on scarcely more than a laboratory scale. The preservation of the high degree of purity and the exactitude of heat treatment which this alloy demands when the production is transferred to the large scale will no doubt present serious difficulties; but, provided the demand for such a material is adequate or can be sufficiently stimulated, the enterprise of the great firm in question can be trusted to overcome such obstacles.

In the production of metals of high degree of purity the same laboratory has yet another achievement to record in connection with platinum metals. For certain of the electrical purposes for which these metals are employed the variations in properties encountered in the best available products was found too great. The matter has been taken up with great success both by the laboratory of the Western Electric Company and by the United States Bureau of Standards. The principal result arrived at was that the best "pure" platinum hitherto obtainable was contaminated with certain impurities, of which calcium proved to be the most important. Platinum metals are very generally melted in calcium containers by means of an oxy-hydrogen flame. Unless this flame is kept strongly oxidising in character it appears that a small amount of calcium may be reduced and allowed to alloy itself with the platinum. Both spectroscopically and by electrical measurements of the properties of the metal the presence of such an impurity can be traced. By varying the method of melting, and particularly by using a highly oxidising flame, this contamination can be prevented, and this is now a well-developed process. The Northrupp high-frequency furnace offers particular advantages for melting platinum in a highly oxidising atmosphere and has proved extremely useful in the production of this very high-grade material. Quite apart from its uses in the electrical appliances in which the Western Electric Company is mainly interested, this very pure material should be of very great value in connection with the use of platinum metals for accurate high-temperature measurement, both by thermo-couples and by resistance thermometry. In both cases the advantage of a perfectly reproducible standard of purity is very great, and it may serve to place this whole branch of very important physical measurement on a better basis.

One further item of very special interest, selected as another example from numberless others, which came under the writer's notice at the Western Electric Laboratory may be mentioned. This is the production as a matter of laboratory routine of direct, sound, gas-tight joints between glass and copper, made by direct fusion or welding in the blow-pipe. Formerly it has always been thought that it would not be possible to "weld" glass to any metal unless the metal had a coefficient of thermal expansion very similar to that of the glass. Platinum fulfils this condition, and so do certain alloys of the nickel-steel type, and successful welds between them and glass have frequently been made. Copper, however, has a very much larger thermal expansion than glass, and if it were attempted to fuse a thin copper wire into a glass tube in the ordinary way the joint would generally crack. The joints seen at the Western Electric Laboratory, however, were between glass and copper tubes, the latter being of slightly larger diameter and welded over the glass tubes. All that is necessary is that the copper tube should be a good fit on the glass tube and that the copper should be thin. The joint is made by means of a blow-pipe flame, and during this process a certain amount of copper oxide passes into the glass in the region of the weld. This probably brings about the formation of something like a "transition layer" of copper-containing glass having a higher thermal expansion than the body of the tube. At all events, such a joint is easily made with the blow-pipe and stands well. Apparently the great ductility of the copper and the closeness of the adhesion to the glass work together to overcome the destructive effects of the contraction strains. The joints were seen in extensive laboratory use, but the applicability of the process to industrial uses is evident and is not likely to be long delayed.

GLASS.

The American glass industry presents a striking contrast to the corresponding industry in England. Here mechanical processes are even now only gradually ousting skilled hand work. In America, on the other hand, the difficulties of securing adequate supplies of skilled glassworkers, and the even greater difficulty of dealing with them in a satisfactory manner, has led to the rapid evolution of processes which almost entirely eliminate skilled labour. This evolution has been the work of engineers and has taken the form of courageous attempts to use mechanical appliances and devices in spite of difficulties which at first must have been very formidable. Glass in regard to its manipulation and treatment is in every way more difficult than metal. For one thing, it is transparent, so that internal defects of a very minute nature become seriously important. Next, it is workable in the ordinary way by mechanical means other than grinding or polishing only at high temperatures, and at those temperatures the surface of the glass is extremely sensitive either to mechanical injury or to chemical contamination. The ordinary processes of manipulation, and more particularly of finishing, which are so readily and successfully applied to metal, cannot be used with glass. Taking for an example the production of a sheet of window glass, any such process as rolling is inapplicable unless the glass is subsequently to be ground and polished. The reason is that the surface of the glass is left comparatively rough and irregular after rolling. Bessemer long ago thought of making sheet glass by allowing the molten glass to overflow from a furnace container and then passing it between rollers. This process is now in actual use in the plate glass plant of Ford Motors at Detroit. Here the glass flows steadily from one end of a small tank furnace and is brought into the form of a flat sheet or strip by means of rollers. From these it passes as a continuous sheet down a very long annealing kiln or "lehr," which it leaves at the far end, quite cold. As the continuous sheet emerges workmen cut it into pieces of the desired size, which are then fixed to suitable "tables" and passed back down the long hall, being successively ground and polished by a series of automatic machines. There is in this nothing that really involves any new principles; it is merely the application of engineering ingenuity to make of the ordinary process of plate glass manufacture a continuous mass-production process in which there is very little manual work. Scientific control is used in this particular works, but mainly for regulating and economising the use of abrasive and polishing materials. The glass actually turned out, which is used for wind shields, &c., on Ford cars, is of fairly good quality, and of a distinctly greenish tinge, but it is claimed that such a tinge is preferable to clear white for windscreen purposes.

The problem of the rapid and economic production of sheet glass has been solved in several ways also by the use of engineering methods rather than by following any novel scientific principle. At the Arnold (Pittsburg) plant of the American Window Glass Company the glass is still drawn into cylinders and then split and flattened. But while the hand-blown cylinders were necessarily limited in size and weight to what one man could manipulate, here the cylinders are drawn to lengths of 30ft. and a diameter up to 36in. This is accomplished in a remarkable manner, the molten glass being taken from a very large tank furnace in ladles from which it is placed in wide, shallow fire-clay pots maintained at the desired temperature by subsidiary heating. From these pots the cylinders are drawn by the insertion of a suitably shaped iron disc or "bait" to which the glass adheres. As this disc is drawn up air pressure is applied to the interior and the glass blown out to a shoulder of the desired diameter; as the drawing proceeds air is blown in so as to maintain the cylinder of uniform diameter. Afterwards the great cylinder is detached and cut up and split prior to flattening. The flattening, however, is relatively a simple matter, since each piece has only a comparatively small curvature instead of being a complete cylinder as in the older processes. The resulting glass is good, but not entirely free from certain defects, particularly slight longitudinal striation, due to the method of manufacture. It is claimed that these can be avoided, but they were not absent from any of the product which the writer saw. Scientific control in this particular plant appeared to be carried to a considerable extent, both in regard to the raw materials and the various stages of the process. The composition of the glass used—a relatively very hard glass as compared with hand-blown sheet glass—and the speed of drawing, air pressures, &c., seem to have been arrived at rather by a process of direct experimentation—"trial and error," in fact—than as the result of any really scientific study of the problems involved. This is not, perhaps, surprising, since the real foundations

* No. IV. appeared October 5th.

for a scientific study of glass and the many difficult problems connected with it are only now being laid. Here the American industry has had no great fund of British or continental research to draw upon, nor has it so far contributed very largely to such a fund.

Still more striking from the practical point of view, although less spectacular, is the production of sheet glass by the Libby-Owens process, which the writer had the privilege of seeing at work at Charlestown, West Virginia. Here the glass flows from the tank furnace into a small projecting basin. From this it is drawn vertically upward, in the first instance by means of an iron rod acting as "bait." If glass is drawn up in this way the sheet first formed rapidly contracts to a thread or rod and generally breaks off. Here, however, this contraction is prevented by the simple device of chilling the edge of the sheet as it emerges from the bath of molten glass. In this way a sheet of constant width and thickness—depending only on the rate of drawing and the viscosity of the glass—is produced. In the newest form of the Fourcault process this sheet is drawn continuously upward to a considerable height and then cut off in lengths of the desired size. In the Libby-Owens plant, however, the glass is, at a short distance above the bath, bent over at right angles over a roller, the glass being softened for the purpose of undergoing this bending by means of a row of gas burners. It is surprising to find how well the glass stands this rather drastic treatment, the surface defects caused thereby being remarkably few. After it has passed over the roller the glass travels down an annealing oven or "lehr," being drawn forward by friction wheels operating upon the edges of the continuous sheet. These edges, which are deeply marked by these wheels, are, of course, afterwards cut away. At the far end of the "lehr" the glass emerges at a moderate speed and is cut up by the workmen as it comes, being afterwards cut to size and sorted in the usual way. The quality of the resulting glass is remarkably good in every way, more particularly in the thicker varieties of sheet. The rapidity of production is very striking, as there are twelve tank furnaces operating in this manner side by side. Even in this remarkable plant, however, scientific control seems to be mainly, if not entirely, a matter of routine control of supplies of raw materials.

Another branch of the glass industry, which has been even more completely mechanicalised than the production of sheet, is the manufacture of bottles, containers, and electric lamp bulbs. In connection with these industries, however, some distinctly important research laboratories have been established, although some of them are more concerned with the problems and difficulties which arise in the use of bottles and containers than with manufacturing processes. The bottle-blowing machine is a much older invention than the mechanical appliances for producing sheet glass, so that they are better known in England and require only brief reference here. Quite a number of different types of blowing machines are in use; thus the Nela Park lamp works use the Westlake machine, while a large share of the bottle production of America stands to the credit of the Owens machine. In their original form the Owens machines appeared to be formidably complicated, but modern improvements have led to very considerable simplification. In all types of bottle machines one of the greatest difficulties seems to reside in the moulds, more particularly in those into which the molten glass is first of all sucked from the furnace. These so-called "measuring moulds" must be provided with fine openings through which suction is applied, and they are exposed to a relatively very high temperature and to the cutting action of the molten glass while still very hot. At the works of the Owens Bottle Company at Toledo, Ohio, a small metallurgical research laboratory had been installed for the purpose of improving these moulds, and similar efforts were in hand at Nela Park. It is, however, to some extent still an unsolved problem, which is also receiving attention in England.*

GLASS AND CERAMIC RESEARCH.

While the application of science to the glass industry is not very apparent in the glassworks themselves, it would be a serious mistake to suppose that there are no very great research activities in America in regard to glass and the allied subjects of ceramics and refractories. The writer had the privilege of attending, as a guest, the 1923 annual Convention of the American Ceramic Society at Pittsburg, and this great gathering gave evidence of a deep interest in the more scientific side of the industries in question. Further, both at a number of colleges and universities, as also at the Bureau of Standards and the Geophysical Laboratory at Washington, very interesting work on these subjects is in progress. The work of the Geophysical Laboratory, which will be referred to in greater detail below, has furnished a most important mass of information on the equilibria of some of the systems, such as silica, lime, alumina, on which so much depends in this subject, and this fundamental work has attained world-wide appreciation. This work, it may be interesting to recall, was undertaken by a laboratory mainly interested in the problems of physical geology; some of the results obtained are, however, proving of very great practical value in connection with refractories. The work of the Bureau of Standards in this connection will be best considered with the many other activities of that great institution, but mention may be made here of researches on glass and refractories in progress at some of the colleges. At the Massachusetts Institute of Technology at Boston work on refractories is in progress, both for purposes of an instruction course to "chemical engineers" and for research purposes, mainly with a view to the solution of certain definite industrial problems. At the University of Illinois, Urbana, there is a large and well-equipped department of refractories and glass, where both teaching and research are in progress. Until recently Professor Washburn was at work in this department on his series of measurements of the viscosity of a series of soda-lime glasses, the temperature range covered being that from complete fluidity of the molten glass—in the neighbourhood of 1400 deg. Cent.—down to the region where the glass becomes very stiff. The method employed consists in measuring the resistance to rotation offered to a cylindrical body immersed in the glass. In spite of some well-founded objections to this method, it appears in Washburn's hands to have yielded concordant results. One of the most serious difficulties lies in calibrating such an apparatus by means of other liquids of known viscosity. It is extremely difficult to find satisfactory liquids whose viscosity at room temperature is of the same order as that of glass in its stiffer conditions. Various syrups have been used, their absolute viscosity being first determined by one of the standard methods, such as the falling sphere. Washburn, however, found difficulty in securing really homogeneous samples. For similar work at the National Physical Laboratory, England, dense glucose solutions have been used and difficulties due to lack of uniformity of the material have not been encountered. This problem of determining the viscosity of glass at high temperatures is, at the present time, of very great practical importance. In all mechanical glass-working processes the molten glass has to flow into a container, sometimes under suction, sometimes under gravity, and it is essential that the amount of glass flowing in an accurately determined time shall be the same within very narrow limits, otherwise a deficiency or an excess of glass will interfere with the proper working of the subsequent stages of the process. It might at first sight be supposed that, since a glass of given constant composition at a definite constant temperature will always have the same viscosity, the latter property could be kept sufficiently constant by careful temperature control. Actually, however, the viscosity varies very rapidly with slight changes of temperature and also with changes of composition which it is not always possible to avoid. Consequently the study of the viscosity of glass in different conditions is a matter of considerable importance, particularly if it were possible to find a direct means of controlling the working of a furnace by more or less continuous measurement of the viscosity of the glass. This a problem which is receiving much attention both here and in America, but an entirely satisfactory solution has not yet been found.

In connection with glass it is interesting to find that in almost all chemical laboratories which the writer visited in America the laboratory glassware was of the well-known "Pyrex" glass. This is a glass of exceptionally high silica content produced by the Corning Glass Company, New York State, and it undoubtedly offers the very great advantage of resistance to heat and to rapid changes of temperature. This property, frequently termed the "thermal endurance" of the glass, depends upon a variety of factors, among which thermal expansion and tensile strength are perhaps the most important. It is evidently more highly valued than a maximum resistance to the attack of chemical solutions, because there are other laboratory glasses which offer decidedly better resistance to solvents, particularly alkalies, than "Pyrex," but few, if any, which are equal to it in thermal endurance. The American chemist, besides desiring to employ a home-made glass, rightly thinks that it is better to use a glass which will allow him to complete an analysis safely without risk of loss through the breakage of a flask or a beaker than to attempt a higher degree of accuracy while running the risk of losing all his work by an untimely crack. English chemists, however, also attach great importance to thermal endurance, but still hope that modern developments in British-made laboratory ware will result in a glass combining maximum chemical resistance with ample thermal endurance, and there is some hope that this aim is likely to be attained in the very near future.

The range of "refractories and ceramics" includes a number of materials which are of specially American origin and which, though used to a limited extent elsewhere, are most fully exploited in their country of origin. These include such well-known materials as carborundum and other forms of silicon carbide, and their derivatives and aluminous materials like "Alundum." They may be regarded as in their origin essentially scientific products, and their exploitation in America is definitely a fruit of the application of scientific results to industrial practice. These special, highly refractory materials, while in the first place mainly of laboratory and scientific interest, are rapidly assuming practical large-scale importance in view of the increasing use of the electric furnace and of very high temperatures. Acheson graphite may be fairly classed with these materials, and the whole group must be regarded as an interesting and important result of the industrialisation of scientific products by the enterprise of American industry. No doubt natural resources, both in raw material and in cheap natural sources of power, have aided this development very considerably, but the enterprise required—the faith in the future possibilities of novel products and materials—none the less calls for sincere admiration.

* See THE ENGINEER, February 25th and May 20th, 1921.

Building a Railway Coach in Six Days.

In view of our recent experiences at Rochester when we explored the methods adopted by Short Brothers in building omnibus bodies on a large scale, we were specially pleased to receive an invitation, from Mr. W. R. Reid, chief carriage and wagon superintendent of the London, Midland and Scottish Railway, to visit Derby and investigate the processes there employed in the intensive production of passenger coaches and goods wagons, as it evidently offered an opportunity for comparing two somewhat similar woodworking schemes both organised by engineers. It was remarkable how similar are the arrangements at the two works, although the railway coaches are naturally more heavily constructed than the omnibus bodies.

All the parts that go to make up a carriage body are turned out in large quantities, and, after the most minute inspection, are sent to the store, from which they are again drawn as required for the building programme in hand. Such a policy means that the parts must be truly interchangeable, and one of the first questions we asked our guide, Mr. E. J. H. Lemon, the works manager, was if he found that the prepared pieces changed shape during their stay in the store. He said that they did not, and explained that most of the timber used was seasoned for at least four years, while some, such as jarrah, coming from abroad, had a long sea voyage, as well, in which to dry out. In the yard we noticed a fine stack of logs—ash, oak, jarrah, mahogany and walnut—which is straddled by a Royce crane. The logs are taken to the sawmill, as required, and are sawn to rough dimensions by two large band saws, one of which is a high-speed horizontal by A. Ransome and Co. From this point onward the whole scheme of the factory has been changed within the last year.

The old practice was for every piece of timber used in the construction of a carriage to be marked out by a coachbody maker, and this man was usually one of the most skilled hands employed in the carriage-building shops. The pieces were then handed over to the workmen, who used hand tools very largely in fashioning the wood and fitted all the parts together individually. The result was, of course, that a considerable amount of time was spent in fitting together the framing, and it required about six weeks from the time the floor was laid until the carriage was ready to leave the shop and be mounted on the underframe.

Now a coach, such as that shown in Fig. 1, is put together, ready to start service, in six days. The vehicle shown is one of the new third-class vestibule carriages, capable of seating fifty-six passengers. They are really most luxuriously furnished, with a table for every four passengers. It will be noticed that the underframe has an exceptionally deep truss, which brings the battery boxes into a very accessible position, and adds greatly to the steadiness of running.

To return to the factory. All the pieces have, naturally, to be sawn out from the rough stock, and taking, for instance, a corner post for the side framing, we noted that it is marked out, round a template, on the timber, and is roughly sawn out with a band saw. Two of the faces are parallel, and can thus be easily prepared in a thicknessing machine. The other two faces are curved to different radii, and are machined upon a vertical spindle mill, with the template firmly screwed on beneath the piece being operated upon. The template bears against the plain part of the cutter spindle, and thus ensures the cutter itself following the same contour. The mortices are cut by chain cutter machines, which have long stop bars arranged behind the tables for fixing the position of the job. All marking out is thus eliminated. Recesses and housings are made by fly cutters equipped with similar positioning apparatus. After the piece has been completed, it is sent to the inspection bench, where it is checked against a large cast iron gauge for general shape, while all the mortices are tested by steel plug gauges.

We were told that when the scheme was first started considerable difficulty was experienced in getting cutters, specially chain cutters, which produced work of sufficient accuracy, but it was evident, from the very nice fit of the gauges in the work, that this trouble had been overcome.

It would extend this article to an inordinate length if we attempted to describe the process of making all the parts that go to form a carriage, but what we have said should serve to indicate the general principles. There are, however, one or two little dodges used in the mill which are noteworthy. In the case of one piece it is necessary to cut the recesses for a

pair of hinges in a rather awkward corner. The work is, therefore, mounted in a jig, on the underneath face of which there are steel plates having holes cut through them to correspond with the recesses required. The whole assembly is then taken to a vertical spindle mill, with the cutter above the table. Immediately below the cutter there is a peg, in the table, that engages in the holes in the jig plates, and by moving the job about, by hand, the mill is is made to cut out the recesses exactly.

Another ingenious device is used in making the tenons of the door-light frames. Instead of cutting away to waste all the wood that has to be removed from the stock, some of it is utilised to make the wedges subsequently used in securing the joint. The rails are fed into a machine equipped with four circular saws. Two of the saws are mounted together on a vertical spindle and cut back the tenon to the shoulder. Then comes a saw, set at an angle, which makes another cut between the first two, and finally, one for slicing off the wedges. The operation is practically as quick as cutting away the stuff as scrap, saves material and provides the wedges in one operation. Another hint we gleaned was the way to grind small twist drills for wood. They are ground with a very steep and flat clearance, and a little point is left standing up in the centre to "enter" the drill.

The machines used in preparing the floor boards are laid out according to an excellent plan. The timber is delivered in open wagons, which are drawn up alongside a stage built up to such a height that a man can feed the lengths on to an elevator single-handed. The elevator dumps the timber on to a gravity conveyor, which delivers on to the table of a planing machine. The man at the delivery end of the planer guides alternate lengths to one or the other of two men operating cross-cut saws, which cut off the timber, approximately, to length—two cross-cutting machines are necessary to keep pace with the planing. The pieces are then fed into another machine for trimming them off precisely to length. This machine has a travelling feed-band running between two circular saws, one to operate on each end of the wood. One end has to be cut at an angle, so this saw is set out of the vertical, but its driving spindle is horizontal, and a connection is made through a universal joint. It seems a bold practice, considering that the speed is, we guessed, 6000 revolutions per minute, but we noticed that there was a good stout guard round the joint. The floor boards are finally sent to another machine where the screw holes are all drilled at once. The whole set of machines is arranged as a long string, with driven rollers between them, so that no man-handling is required between unloading from the truck and delivery of the finished article. There are, of course, attendants at each machine, but they have no fatiguing work to do.

Although some of the machines in the mill are truly one-purpose machines, others have, naturally, to be used on several operations, and then one of the disadvantages of modern woodworking machinery becomes apparent. We refer to the high proportion that the setting-up time bears to the total time taken to do any job, *e.g.*, the setting-up of a four-cutter planing machine may take anything up to one hour, and with the fast feeds, up to 250ft. per minute, that are now possible, a fair-sized order can be put through in, say, half-an-hour. In order to reduce the proportion of the setting-up time to the total time taken to do the job, the design of the various parts of the carriages was carefully gone over, with a view to making as many of the articles as possible of the same type, so that larger quantities could be put through in one operation, thus economising in labour and setting-up time. An example of this special designing is seen in the corridor partition, which, before the present methods came into use, was made in one piece, whilst the third and first-class corridor partitions were different as regards the length of rails, size of panels, &c., owing to the difference in size of the first and third-class compartments. By splitting up the partition and making it in three parts, two of the parts in either first or third-class partitions can now be made interchangeable. Certain of the rails that go to make up the corridor sliding door are also made standard with the partition. Only the third, or centre, piece has then to be a different size for first or third-class compartments. A number of the other interior fittings of the carriages have been altered in a similar manner.

As we have already mentioned, the finished parts are sent into the store and drawn out again as required. The materials are all requisitioned in the quantities necessary for building a carriage and are taken, on electric trailers, to the assembly departments. The smaller units, such as doors, seats, &c., are each made in special sections of the building, while the larger parts are put together adjacent to the final assembly station.

There are two assembly tracks in the carriage department, each capable of accommodating two 57ft. carriages. The complete underframes are run in on these tracks, and the bodies put together in their final position. The first operation is on the floor—see Supplement. It will be noticed that when the photograph from which this engraving has been made was taken, the bogies were not mounted under the frame, but the construction is the same whether the bogies are in position or not. A low platform has, however, been built along either side of the track to bring the men up to a convenient level with their work. The course of operation is as follows:—One of the bottom side members is bolted down to its sole-bar, the cross bearers, middle bearer and the other bottom side are slipped in place, and a cramp, which can be seen in the view, is used to draw the tenons hard up into their mortices. The clamp is provided with ball-bearing rollers, and a powerful screw at each end, so that the framing can be pulled up tight from end to end progressively. The floor boards are then dropped in place and screwed down. It takes about eight hours to put a floor together.

Simultaneously with the work on the floor, another gang is building the roof on a jig, ends are being made, and the sides are being assembled elsewhere. Views

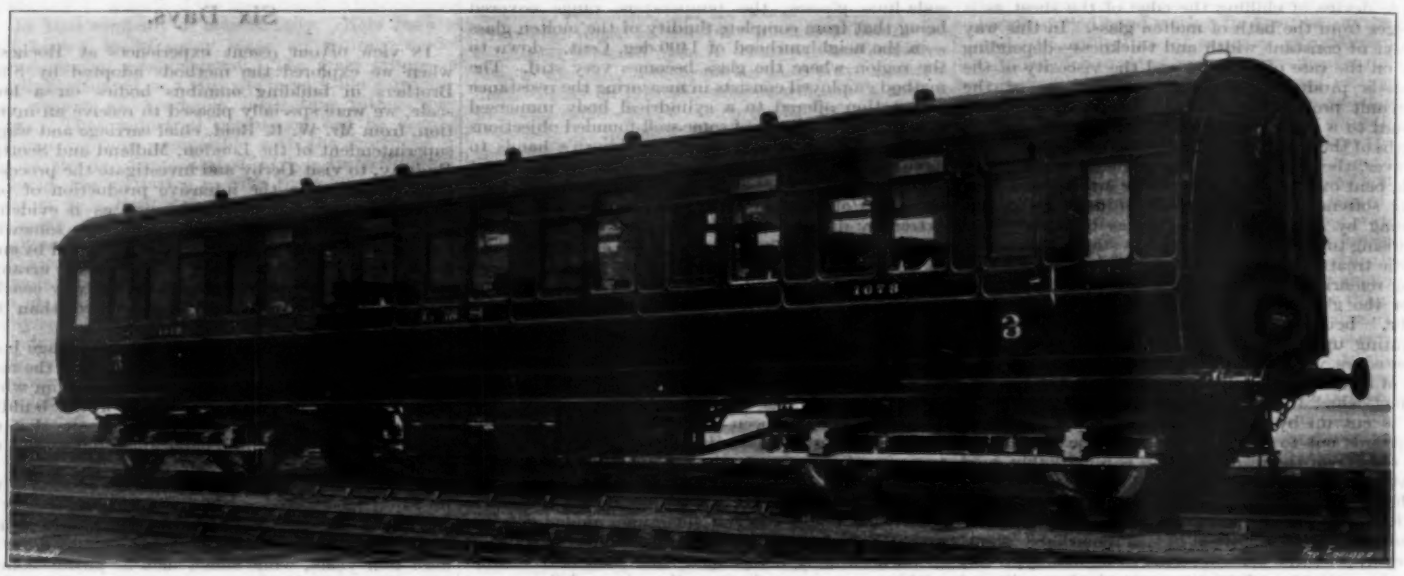


FIG. 1—LONDON, MIDLAND AND SCOTTISH RAILWAY NEW THIRD-CLASS VESTIBULE COACH

FIG. 2—SCREWING PARTITIONS IN JIG

FIG. 3—COMPLETED ROOF OF COACH

of these operations are shown in our Supplement, in which yet another picture illustrates the apparatus used in cramping up the door frames, and is interesting, as this machine was the first developed in the process of re-organising the works. It has a wooden frame, curved to the shape of the door, and is covered with zinc. Three compressed air cylinders, working at a pressure of about 90 lb. per square inch, are used to drive the tenons into their mortices. This illustration also shows very clearly one of the machine screw-drivers extensively used throughout the shop. They have an automatic feed and save a great amount of hard, uninteresting labour. Flat work is cramped in a belt-driven American machine—see Supplement—which is fitted with a clutch and knock-out to prevent it over-driving the tenons.

FIG. 4—CRAMPING AND WEDGING DOOR-LIGHT FRAMES.

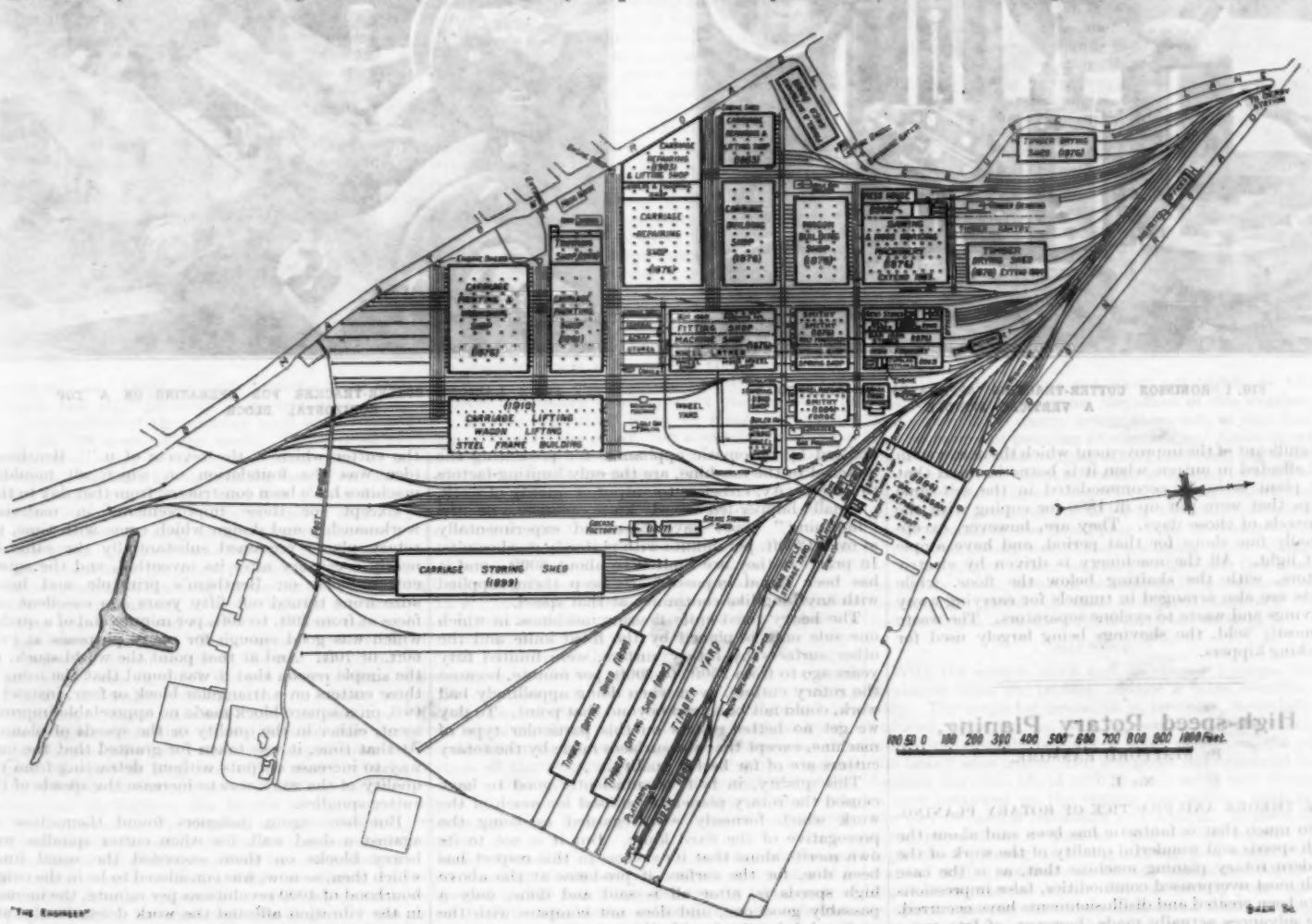
FIG. 5—ASSEMBLING AND CRAMPING DOORS

There are several other types of cramping apparatus in use for lighter parts, including the rig—shown in Fig. 4—which is used on door-light frames, when the little wedges already referred to are used. The flat doors used along the corridors are assembled as shown in Fig. 5.

The partitions for the compartment type of carriage are made of two thicknesses of planking, running across one another, which are screwed together as shown in Fig. 2. It will be noticed that the work is mounted on a turntable, so that the mechanical screw-driver can reach the whole surface.

The final stage in building a carriage comes when all the units are assembled on the completed floor, and we had the good fortune to be in time to witness the operation—we believe, however, that Mr. Lemon must have taken some pains to see that we were there in time. First, the ends are reared up in place by half-a-dozen men, and two long bars are hooked over the top rail, above the door-posts. These bars are connected with a pneumatic cylinder on a little trolley, which can be seen behind the buffer in two of the views in our Supplement. Air is turned on and the end is pulled down hard into place. The other end is treated similarly, and then the sides are put up. In tightening up the joints at the bottom of the side posts a simple form of lever cramp is employed. A casting with a set of bold ratchet teeth is slipped over the bottom rail, and a lever, on which there is pivoted a vertical rod, is engaged with the ratchet. The top of the rod is hooked over one of the rails of the framing, and the whole arrangement provides a very powerful cramp, which can readily be moved about to give a pull down where necessary.

As soon as the sides are secure the roof is picked up on a light runway—as shown in one view in the Supplement—is travelled over the carriage, and is heaved down by the same style of cramp, only the rods are lengthened to reach up to the roof. In view of the fact that the roof cant rails have ninety mortices in them, which have to register with ninety tenons on the side framing, we were pleasurably surprised at the ease with which the roof was got into place. A few bolts have to be put in the corner brackets, and it may be said that the carcase of the carriage is complete. The gang we saw do the job was fourteen strong, and we timed them to take exactly 24 min. from the time they were mustered.


CARRIAGE STORING SHED (1899)
TIMBER YARD
TIMBER DRYING SHED (1910)
TIMBER DRYING SHED (1910)
TIMBER DRYING SHED (1910)
TIMBER DRYING SHED (1910) EXTENSION
CARRIAGE REPAIRING & FITTING SHOP (1903)
CARRIAGE REPAIRING SHOP (1876)
CARRIAGE BUILDING SHOP (1876)
CARRIAGE PAINTING & TRIMMING SHOP (1876)
CARRIAGE PAINTING SHOP (1876)
(1910) CARRIAGE LIFTING WAGON LIFTING STEEL FRAME BUILDING
FITTING SHOP MACHINE SHOP (1876)
WHEEL YARD
SMITHY (1876)
SPRING SHOP
SAWING & MACHINE SECTIONS (1876)
SAWING & MACHINE SECTIONS (1876) EXTENDED 1906
WAGON BUILDING SHOP (1876)
WAGON REPAIRING SHOP (1876)
WAGON PAINTING SHOP (1876)
WAGON TRIMMING SHOP (1876)
WAGON STORING SHED (1876)
WAGON STORING SHED (1876)
WAGON STORING SHED

work being done on them, and the accuracy of the work can be seen by looking at any of the carriages that have been assembled by this method; all shoulders will be found to be square, and the workmanship is certainly of a very high order. The door lights, photograph frames, &c., are also all assembled on jigs, and very rapid production can be obtained.

The wagon building-shop is quite separate from the carriage department, although it is dependent on the same saw mill for the parts used in making up the wagons. In it there has just been started a system of the same general type as that employed on carriages, and although the whole of the detail arrangements had not been completed at the time of our visit, we saw enough to appreciate the thorough way in which the engineers have studied all the phases in the completion of a wagon.

The first operation is to assemble the floor, which is cramped up on all sides by hydraulic rams, and is built upside down for convenience in getting the ironwork into place. The bottom is then picked up by a crane and turned upside down over a track. The wheels are run into place, the axle boxes slipped on, and the springs arranged. There are five subsequent stages in the assembly, and for each one the wagon is drawn between stages set at such a height that all the material required for that stage gravitates into place. Six wagons are linked together by long couplings, so that as the completed wagon is hauled out of the shop, the other five are moved up a stage.

At the present time four passenger carriages are being turned out from the works every week, and it is significant of the improvement which the new system has effected in output when it is borne in mind that the plant is easily accommodated in the self-same shops that were put up in 1880 for coping with the demands of those days. They are, however, exceptionally fine shops for that period, and have ample roof light. All the machinery is driven by electric motors, with the shafting below the floor, while ducts are also arranged in tunnels for carrying away shavings and waste to cyclone separators. The waste is mostly sold, the shavings being largely used for smoking kippers.

High-speed Rotary Planing.

By STAFFORD RANSOME.

No. I.

THE THEORY AND PRACTICE OF ROTARY PLANING.

So much that is fantastic has been said about the high speeds and wonderful quality of the work of the modern rotary planing machine that, as is the case with most overpraised commodities, false impressions have been created and disillusionments have occurred. The advances actually made, however, of late years have been sufficiently startling for the process to stand on its merits without exaggeration of any sort.

Americans, who unquestionably have had a great share in the improvements that have been brought about, are apt to say that the rotary cutter can now plane as fast and leave as good a surface as the fixed knife. As a matter of fact, it does not, and it never will do either of these things. To the engineer who does not allow his enthusiasm to run away with his logic, this fact is plain enough for the simple reason that the faster the material is passed over a fixed knife, the better will be the quality of its work; whereas the faster it is passed over the rotary cutter, the worse must the result be.

There is another equally unanswerable reason. It is that although if you feed the wood to a rotary cutter sufficiently slowly it will produce a surface which to the naked eye is perfectly flat and so smooth as to appear almost polished, it cannot possibly be so theoretically, as the action of the rotary cutter is and always must be to produce a series of parallel grooves and ridges all along the surface of the board which is subjected to its influence.

RIDGING.

Each ridge and hollow marks the passage of one cutter, the distance between the ridges being determined by the number of cutters that have struck the wood in a given length of board. The depth of the grooves is determined by the diameter of the circle formed by the cutter track.

But, although this ridging effect is always there, it can be reduced to such microscopic dimensions by planing slowly on a good machine, that if a comparatively short board thus planed be placed on the top of another and the upper one be lifted, the under board will rise with it. That was, in fact, the test of good rotary planing on the trying-up machine fifty years ago, and nothing better than that is obtainable to-day. Nor do we get anything approaching such a result at the modern high speeds.

We must revert for one moment to the fixed knife. The amount of horse-power available, the nature of the feeding gear and the capacity of the human being, assisted by automatic appliances for presenting the material to the machine, are the only limiting factors to its capacity, either as to output or quality of work.

Small hopper-fed fixed knife planers, of the "lightning" type, have been fed experimentally at over 1200ft. per minute with perfectly good results. In practice, they are limited to about 800ft., and it has been found impossible to keep them supplied with anything like continuity at that speed.

The heavy fixed-knife flooring machines, in which one side only is planed by the fixed knife and the other surfaces by rotary cutters, were limited fifty years ago to from 250ft. to 300ft. per minute, because the rotary cutters, even when doing appallingly bad work, could not be forced beyond that point. To-day we get no better results on this particular type of machine, except that the surfaces made by the rotary cutters are of far better quality.

This quality, in fact, is sufficiently good to have caused the rotary planer to be used for much of the work which formerly was regarded as being the prerogative of the fixed knife. But it is not to its own merits alone that its success in this respect has been due, for the surface it produces at the above high speeds is, after all is said and done, only a passably good one, and does not compare with the surface left by the fixed knife.

But with the advance in rotary planing, a similar advance has been made in sandpapering machines, both in design and the quality of the material used on them, and we may truly say that the modern rotary planer plus the modern "sander," with its six or eight drums, makes a very fair substitute for the fixed knife planer, quality for quality and speed for speed.

The true importance of the high-speed rotary planer is not to be based on what it can do as a competitor of the fixed knife, which after all only comes into a small corner of the field occupied by the rotary machine. Its real value, which even now is not fully appreciated by many owners of planing mills, lies in the fact that it will give us a quality of planing at, say, 250ft. per minute, which is in every way equal to that produced by the ordinary square block rotary planer at 50ft.

THE EVOLUTION OF PLANING.

Before we can realise how high-speed planing is done to-day, we must run very briefly over the evolution of the rotary planer since its first inception by Sir Samuel Bentham in the reign of George III., just 130 years ago. Bentham's invention was not merely a single-spindle machine; it covered planing on all four sides of the wood simultaneously. In his original scheme—which, by the way, also foresaw and forecasted "dovetailing" and other processes, practically as we know them to-day—the basic feature was a revolving rectangular block to which the cutters were bolted. This form of cutter-block remains practically the same now as conceived by that wonderful old dreamer of dreams. In spite of its theoretical shortcomings, and they are many, and except for high-speed planing it still retains its position as the most popular and versatile cutter-block on the market.

Similarly, Bentham conceived the making of mouldings by the same process. "If," says he, in his quaint but explicit specification, "the circumference of a circular cutter be formed in the shape of any moulding and projected above the bench no more than is necessary, the piece, being shoved over the cutter, will thus cut a moulding corresponding to the cutter which is the reverse of it." Bentham's idea was the foundation on which all moulding machines have been constructed from that day to this.

Except for those improvements in materials, workmanship and design which come with time, the rotary planer remained substantially the same for nearly a century after its invention, and the square cutter block on Bentham's principle and heavy adze irons turned out fifty years ago excellent surfaces at from 20ft. to 40ft. per minute and of a quality which was good enough for many purposes at even 60ft. or 70ft. And at that point the world stuck, for the simple reason that it was found that the using of three cutters on a triangular block or four, instead of two, on a square block made no appreciable improvement, either in the quality or the speeds of planing. At that time, it was taken for granted that the only way to increase outputs without detracting from the quality of the work was to increase the speeds of the cutter spindles.

But here again designers found themselves up against a dead wall, for when cutter spindles with heavy blocks on them exceeded the usual limit, which then, as now, was considered to be in the neighbourhood of 4000 revolutions per minute, the increase in the vibration affected the work deleteriously, and so defeated its own end, viz., to do equally good work at higher rates of feed. It was also regarded as an accepted fact that, no matter how many cutters were placed on a block, only one of them actually did the cutting, because, however carefully the cutters were set, which was done by measuring the overhang of each cutter from the corner of the block, perfect mathematical accuracy was impossible except by a fluke. This idea, although to some extent fallacious, became so ingrained that in many cases great care in the measurement for setting was abandoned, and

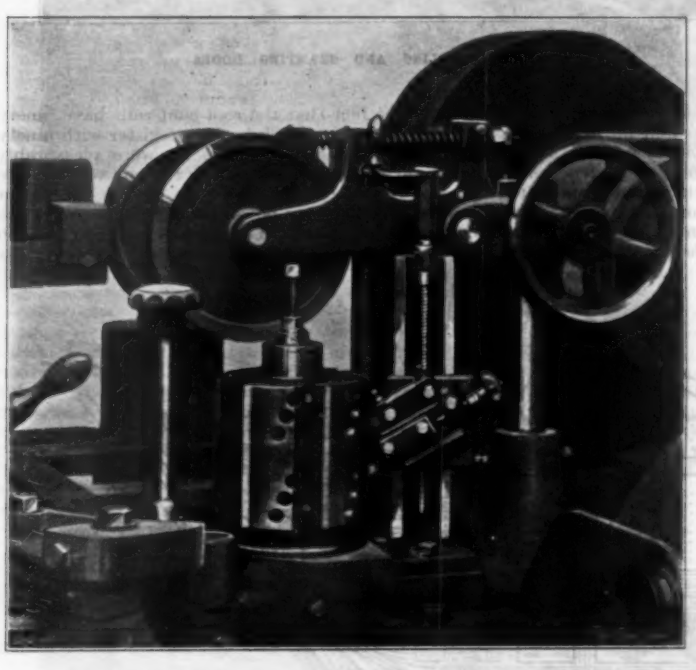


FIG. 1—ROBINSON CUTTER-TRACKING APPARATUS AS ADAPTED TO A VERTICAL SPINDLE

FIG. 2—RANSOME CUTTER-TRACKER FOR OPERATING ON A TOP HORIZONTAL BLOCK

one of the cutters was regarded merely as a counterbalance for the other.

It was, of course, a mistake to assume that the less prominent cutter did none of the work because, unless the rate of the advance of the material was slower per revolution of the block than the difference between the projections of the two cutters, the less prominent cutter removed a considerable portion of the wood, although it never recorded its work on the surface of the finished material, because it could never touch that point. The difference between the projection of the cutters might only be insignificant, but the surface left on the wood showed only the work of one and not of two cutters. It was a long time before it was realised that the fault did not necessarily lie in the difficulty of setting the cutters accurately or in the cutter shifting slightly in the process of tightening the bolts after setting.

But though these were unquestionably factors to contend against, the real cause of the difficulty was for a long time ignored. It was that the axis on which a spindle revolves is not necessarily identical with the mathematical centre of the spindle. Therein lay the real root of the evil, because when a spindle with a heavy cutter block with its cutters revolving at 4000 revolutions per minute and subject to all the stresses set up thereby, its axis may be and generally is slightly displaced from the centre of the spindle. The difference may be and in practice often is hardly measurable, but it is sufficient to vitiate the true circle of the cutter track, and thereby to prevent certain of the cutters from touching the surface of the wood. We must bear in mind that the difference between good and indifferent planing is a question of thousandths of an inch.

TRACKING.

The only means of remedying this defect was to ignore the spindle centre and to correct the circle of the cutter track *at its periphery* while the spindle was revolving at its normal speed. This process of

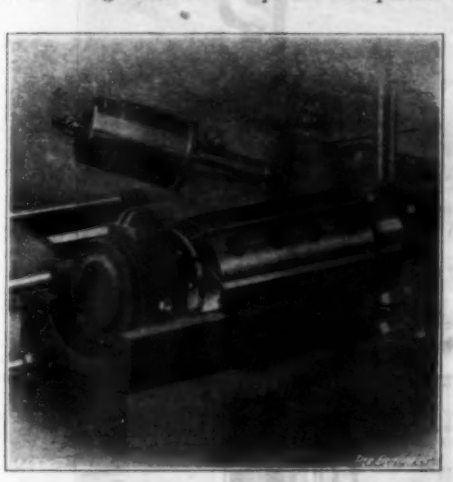


FIG. 3—ROBINSON ELECTRICAL SHARPENER OPERATING ON A BOTTOM HORIZONTAL BLOCK

"trueing-up" or "tracking" the cutters—or, as the Americans call it, "jointing,"—ensures that each cutter, irrespective of the number used on a block, shall do its full share of the work. The process is simplicity itself, and is merely an elaboration of a process which has been in vogue in the case of circular saws for certainly 200 years, and has always been known as "rubbing down." The process of rubbing down a saw consists merely in applying to the teeth of the saw when in motion some hard gritty substance which will blunt first the more prominent teeth and is advanced gradually, blunting them all in the process, until the least prominent tooth is lightly touched. When that point has been reached a perfect cutting circle has been arrived at. That circle is not struck from the mathematical centre of the saw blade, but from the actual axis on which the saw is revolving.

The only difference between the processes of "rubbing down" a saw on a bench and "trueing-up" cutters on a block is that in the former case the operator can apply by hand and without preparation any piece of stone or fragment of an emery wheel, whereas to rub down the cutters of a planing machine a correct line throughout the length of the cutter must be maintained by the grinding agent in its work.

This requirement is readily met by making provision on the casting of the planing machine to accommodate a slide which carries a tool holder—as shown by Figs. 1 and 2. The tool is a small emery slab or stick or "pencil," which is traversed the length of the cutter and is approached as required towards the axis of the spindle until the extremities of all the cutters have been touched. This process creates what is called a "heel" on the edge of the cutters, and the extent of the heel naturally varies with the relative prominence of each cutter. Fig. 1 shows the tracking apparatus on a Robinson planer, with a vertical slide in position for operating on one of the side spindles. On the same slide a revolving emery stone is used for sharpening the cutters after tracking. Fig. 2 shows a different design of tracker, operating on the top horizontal spindle of a Ransome planer. The cutters have been previously set, and as the process of trueing-up naturally destroys the fine edge, at all events of the more prominent of the cutters, the accuracy of the previous setting is of great importance, because badly set cutters necessitate the removal of more material before the true circle is reached. Whatever that amount may be on each cutter, the heel is ground away by a portable re-sharpening machine, electrical or otherwise—Fig. 3—which makes use of the same slide for its traversing action as that used by the emery tracking stick. Thus there is a perfect accord between the actions of tracking and re-sharpening. Here, again, in the re-sharpening is great scope for waste of material and time by careless handling, for unless attention is paid to stop the sharpening at the precise point on each cutter at which the tracking pencil ceases to mark it, the effect of the tracking will be undone, as the true circle of the cutter track will be destroyed.

It would seem unnecessary to describe so simple an operation in such detail, but for the fact that its action and importance are not generally appreciated, and that it is one of the two keys that have opened the door to modern rotary planing and increased the speeds from four to six-fold as compared with the formerly accepted standards.

SQUARE AND CIRCULAR BLOCKS.

While there existed nothing better than the old square cutter block with its clumsy slotted cutters, ¾in. thick, made up of a thin hard steel face, backed with iron or mild steel, and with its back unsupported for perhaps as much as from 2in. to 3in. between the cutting edge and the holding-down nuts, trueing-up was of but little value. There is, of course, no more mechanical difficulty in applying the trueing-up device to the old-fashioned cutters than to the new ones, but the effect of trueing-up is not so definite if there is any vibration or spring in the extremities of the cutters under operation, which is sure to be the case if the cutters on a square block are greatly overhung beyond the edges of the block. For successful tracking, it is essential that the cutters at their edges shall be as rigid as the tracking stick which reduces them.

Owing to the adze irons on the square block being without back support for so long a distance from their cutting edges, the quality of their planing depends primarily on the strength of the cutter itself. This is sufficient for planing at moderate speeds, but when forced beyond a certain point, such cutters, whether trued-up or not, vibrate in operation too much to make the best work a possibility. The advent of the thin high-speed cutter, which cannot work at all unless it is held firmly on both sides close to the cutting edge—as shown by Fig. 4—afforded the necessary rigidity for accurate "tracking," and finally solved the problem of high-speed planing.

The net result of perfect tracking caused a great sensation; it was the solution of that problem of how to make each individual cutter bear its full share of the work. Thus, in theory, at all events, a block with eight cutters properly tracked ought to do work of a given quality at eight times the speed of a square block with two cutters, only one of which is penetrating to the surface of the finished work.

In practice this is not precisely the case, and it is a little difficult to make accurate comparisons because, whatever the theory of the perfect planing machine may be, the conditions when so many cutters are working "up to the collar" on a number of spindles simultaneously are not the same as those obtaining in the slower-speed machines. The stresses set up are of a totally different nature from those on a machine in which on each block a single cutter only is striking the wood to the full depth of the cut. Thus, the finished surfaces, left by the two types of cutter block, whether good or bad, as the case may be, are not at all alike and do not admit of comparison.

In a "four-side" planer with square blocks, with two cutters on each, revolving at 4000 revolutions a minute, the material is only subjected to some sixty-six full blows from the cutter in one second and to sixty-six minor blows by the second cutter on each block—the less-prominent cutter which is not doing its full share of the work. These minor blows, however, lessen the shock of the more severe blows by the prominent cutter by relieving it of the removal of a portion of the material, all of which with trued-up cutters would have to be removed by each individual cutter. In such a machine the quality of the work, whether good or bad, will at all events be perfectly regular.

In a "four-side" planer with circular blocks and eight trued-up cutters on each block, the material is subjected to 533 full blows per second from each of from four to six blocks. Conditions of vibration which do not apply to the slower machine are in consequence set up, and the work is affected accordingly. It is for this reason that there have been many disappointments to people who have imagined that they could transform their ordinary planing machines into high-speed planers by merely exchanging their square blocks for circular blocks and by tracking their knives. Such machines are seldom capable of standing the much more severe conditions incidental to high-speed planing, even if a sufficiency of horse-power is available.

In the first place, the feeding gear and the pressures will be found to be quite inadequate for the purpose, and, in the second, it is almost certain that the design of the machine does not lend itself in other respects to the required conditions, notably to the application to the various spindles of anything but makeshift tracking and sharpening devices and to the ready clearance of the mountains of chips which are an unavoidable feature in high-speed planing. Thus, while, by adopting circular blocks and thin knives on ordinary machines, work may be greatly improved and the output be increased somewhat, it is useless to try to attain the really high speeds on anything but a machine properly constructed for the purpose.

The quality of rotary planing, whatever the rate of feed may be, is finally determined by the distance between the ridges left by each cutter on the surface of the wood and on the depth of the grooves between those ridges. The distances between ridges is determined by the number of cutters that strike the wood in a given length of board; thus they increase with the rate of feed. It is generally accepted that to attain passably good work there should not be less than about eight ridges to the inch in high-speed work. With eight cutters on a block revolving at 3600 revolutions per minute, this represents a feed at the rate of 300ft. per minute, whereas a six-cutter block, revolving at 4000 revolutions per minute, would present the same ridging effect at a feed of 250ft. per minute. We quote different spindle speeds because it is not desirable to run so heavy a block as that required to carry eight knives at as high a speed as the smaller one. Theoretically, the work of the former, even at its higher rate of feed, is better than that of the latter because the cutter track of the larger block gives a flatter curve between the ridges and the higher rate of feed further flattens the curve by increasing the arc of the circle described by the cutters on the wood as it travels past them.

In practice, however, the difference is so slight as to be hardly appreciable if set out on paper. Actually on the wood, however, the ridges are there and to the tutored eye are plainly to be seen, and these ridges have to be sand-papered or scraped off before

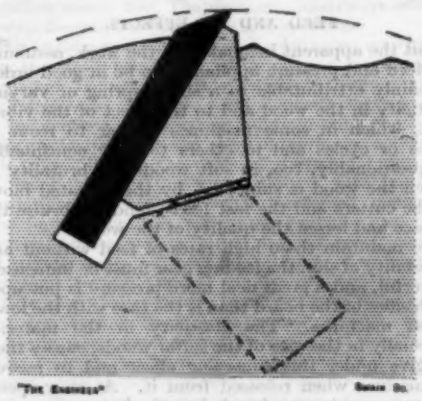


FIG. 4—THIN HIGH-SPEED KNIFE SUPPORTED CLOSE TO CUTTING EDGE

we arrive at a surface which either is or looks truly flat.

If these ridges are not very noticeable as the boards leave the machine, the effect of the weather, and especially of damp, brings them out, as also does the operation of painting or varnishing. Quite apart from the inevitable ridging effect, however, there are many influences which affect the symmetry, if not the spacing of the ridges. Imperfectly fitting bearings or inadequate pressures for holding the material when under operation—or a slipping feed, of course—will throw everything out. But assuming these things to be in proper order, we have to face the fact that no cutter block, however accurately it is balanced in itself, ever preserves that complete accuracy of balance when once the cutters are fixed on to it.

BALANCE.

With the square block and its clumsy cutters, the deviation from the perfect balance is often considerable. The scope for deviation is, however, materially reduced when we use thin high-speed cutters which weigh individually perhaps a sixth of the weight of the heavy adze irons. But the great improvement in balance has come about with the increasing care which is now bestowed on the cutters themselves, both in the way of careful balancing and setting. Neglect of these precautions is just as fatal to the results of high-speed planing as to log sawing is a neglect or want of skill in maintaining the saw blades and adjusting them on the machines. Just as twenty years ago people frequently said that high-speed band sawing was impossible because they did not know how to maintain the saws properly, so to-day do many people maintain that high-speed planing is unsuccessful because they do not trouble to apply science and intelligence to the care and treatment of thin cutters, without which success is impossible. So important is the question of balance if high-speed rotary planing is to be attained successfully that it is no longer a question of merely weighing one cutter against another, but the two ends of each individual cutter must be tested for weight on a see-saw balance, which is as sensitive as an assayer's scale.

A thing which has a deleterious effect on the surface of the work of the rotary planer is a belt which is either too heavy or too tight, or is badly or clumsily joined. Every passage of the joint of such a belt over the pulley of the spindle leaves its mark on the surface of the wood planed. Then there is the pull of the various belts in different directions and at different angles on the vertical and horizontal spindles, and the general jarring effect of four or six spindles running at high speeds and doing such heavy work. These set up such a complex set of vibrations, all of which, though in a good machine they may only be noticeable by touching it, affect the planed surface. Thus, the perfect ridging effect as it would appear if set out theoretically on paper is seldom seen in practice on the wood itself, especially in high-speed planing machines where all these influences are at their maximum.

If, therefore, we are out to get as near to the ideal as we can in respect of a highly finished surface on the rotary planer, we must confine ourselves to a single-spindle machine of the panel-planer type, with a large cutter track and four high-speed steel knives properly trued-up. With such a machine we should obtain the most perfect surface that rotary cutters can produce at about four times the speed attained by the square block and heavy untracked cutters. Though when feeding at 100ft. a minute on such a machine, there would be only twelve or fourteen ridges to the inch, the work should be so good as to require hardly any sandpapering, as this type of machine is practically free from those complex vibrations which jar the work in all four-sided planers, especially those of the high-speed type.

In practice the surfaces left by high-speed planers vary a great deal in appearance, even in boards done on the same machine at the same speeds. The ridging effect of each cutter is not always regularly defined, and different lengths of the same board often have the appearance of being done at different speeds. This, in fact, is sometimes the case, as in all these machines the rate of feed is variable instantaneously in the cut.

FEED AND ITS EFFECTS.

But the apparent inequality in the work, assuming the feed and pressure appliances to be in good order, is mainly attributable to a slight spring or varying elasticity in the wood and to the effect of the vibrations which in some machines appear to recur in series or cycles and in others to vary continually. Unquestionably, too, in soft woods the brutality to which the wood is subjected, by the repeated blows of the cutters and the fast feeds, tends to bruise the surface and lessen the quality of the work.

To maintain these high rates of feed without any possibility of slip, the feeding gear must be immensely powerful, and a great deal more pressure is put upon both sides of the board than is the case with the lower speed machines. The elasticity in the material, especially in the case of the softer woods, causes them to give under this squeezing effect and to recover themselves when released from it. At slow speeds the recovery is complete before the knives come into operation, but when feeding at 300ft. a minute, i.e., 5ft. per second, and if the feed rollers are within from 2ft. to 3ft. of the knives, it frequently happens that these latter come into action before the natural resilience in the wood has enabled the board to recover completely from the squeezing effect of the rollers. This fact accounts for a good deal of the irregular appearance that one finds on the surface of soft wood boards planed at high speeds, because the degree of resilience which is in a board varies considerably as a rule throughout its length. Hard woods, which do not give appreciably to the pressure of the feed rollers, are naturally less affected in this manner.

Strict regularity in the appearance of the work, however, is immaterial from the point of view of what is to happen to the boards afterwards, provided that the difference between the summits of the ridges and the bottoms of the hollows between them is uniform and not too deep.

As before explained, wonderful as are the speeds attained to-day by rotary planers, their work is always dependent on the sandpapering machine for giving it the final touch, and the intelligently worked rotary planer is the one which leaves as little as possible for the sander to do afterwards, and which presents its work to that machine always of a uniform quality, so that the same treatment can be applied to all.

Sandpapering machines at the present day are so perfected that by abusing the facilities they offer and wasting a great quantity of sandpaper, very bad rotary planing can be given a very excellent surface by only one passage through the sander. It is, however, a very false and wasteful policy to force the output of the planing machine unduly, and thus overtax the sander by using it to correct the defects of bad planing.

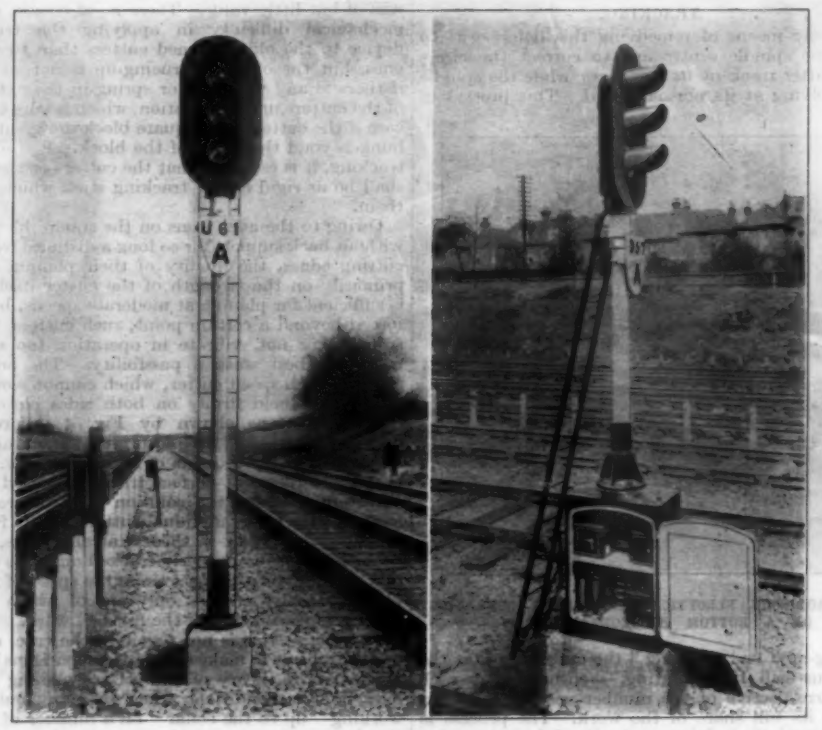
Theoretically, of course, there is no limit to the outputs in high-speed planing if the machines and cutter blocks are designed accordingly. It is merely a question of arranging for a given number of cutters to strike the wood in a given length of board. The practical limit with machines as now designed, as already stated, is about 300ft. per minute with an eight-cutter block. There is, however, no incentive to exceed this speed, because any appreciable increase would be beyond the capacity of present-day automatic board-handling tackle.

The above speed holds good for soft woods only. The limiting factor of speed on hard woods is the capability of the cutters to stand up to their work without breaking. In practice the hard wood maximum may be put at 150ft. per minute.

The next article of this series will deal with the cutter blocks and cutters that have made high-speed planing possible.

Signalling for the Empire Exhibition.

In anticipation of the traffic to the British Empire Exhibition at Wembley a circular loop has been constructed between the High Wycombe and Aylesbury lines at Wembley, and a three minutes' service between Marylebone and the Exhibition Station has been organised. To effect this service it has been necessary to equip the line with automatic signals. The automatic area may be considered as beginning on the down line at Marylebone Goods box advanced starting signal, 1250 yards from the buffer stops in Marylebone Station, and ending at Neasden South box inner home signals, 9024 yards from the buffer stops. On the up line it begins at Neasden South starting signal, 8794 yards from the buffer stops and ends at the Goods box inner home signals. The intervening distance on each line is divided into six automatic signal sections. The lengths of the sections vary to suit the possible speed, and were arrived at after careful tests, made in actual running, had been carried out, to ascertain the exact position each train would be in were trains following each other at three minutes' intervals. The timing was, of course, affected by, among other factors, the gradients, and the lengths of the six sections on the down line are 1080, 1140, 1068, 1182, 1430 and 1874 yards respectively, and on the up line, starting from the Neasden end, 1441, 1223, 1125, 1345, 1330 and 1343 yards respectively.



FIGS. 1 AND 2—WESTINGHOUSE THREE ASPECT DAY COLOUR-LIGHT SIGNALS

In automatic signalling, provision has, as is known, to be made against a signal accidentally being overrun; that is to say, a margin of safety has to be given beyond the section controlled by a signal. In order to make this plain, consider any one of the down-line sections first named, say, the third from Marylebone—that of 1068 yards length. Before the signal for entering this length, situated at the end of the section 1140 yards in length, can change from "stop," not only must the 1068 yards be clear, but an overlap or clearance distance beyond the signal at the end of the 1068 yards and the beginning of the 1182 yards must be unoccupied. This overlap gives the margin of safety to which we have referred. Until automatic signalling was introduced into this country, the term "overlap" was unknown here, but the principle is almost as old as the block system. With block working it is the rule that a train shall not be accepted unless the line be clear for at least a quarter of a mile ahead of the home signal. This requirement is rigidly fulfilled. No deviation from the rule is made to suit falling gradients, calling possibly for an increased distance, or rising gradients, where the "clearance distance" might be reduced. With automatic signalling, as installed on the rapid transit lines in London, the length of the overlap has been reduced to the lowest minimum in order that the signals may go from the "stop" position as early as possible, and thus allow the next train to follow. In the present installation, although steam worked, the principle of the rapid-transit electrically operated lines has been followed, and the lengths of the overlaps have been determined, on a scientific basis, to suit the ruling speed and gradient. In this connection it is important to note that the Reliostop automatic train control is in use on this section of the former Great Central. This apparatus warns a driver, by a service application of the continuous brake and the sounding of a syren, that he is ten seconds' distant from a signal. Another factor that entered into the question of the position of the signals was what is known as the "sighting distance." In this a minimum of ten seconds' distance is given to the driver. Altogether, therefore, there are to be found in this signal installation many praiseworthy details not hitherto provided on a steam-worked railway in this country.

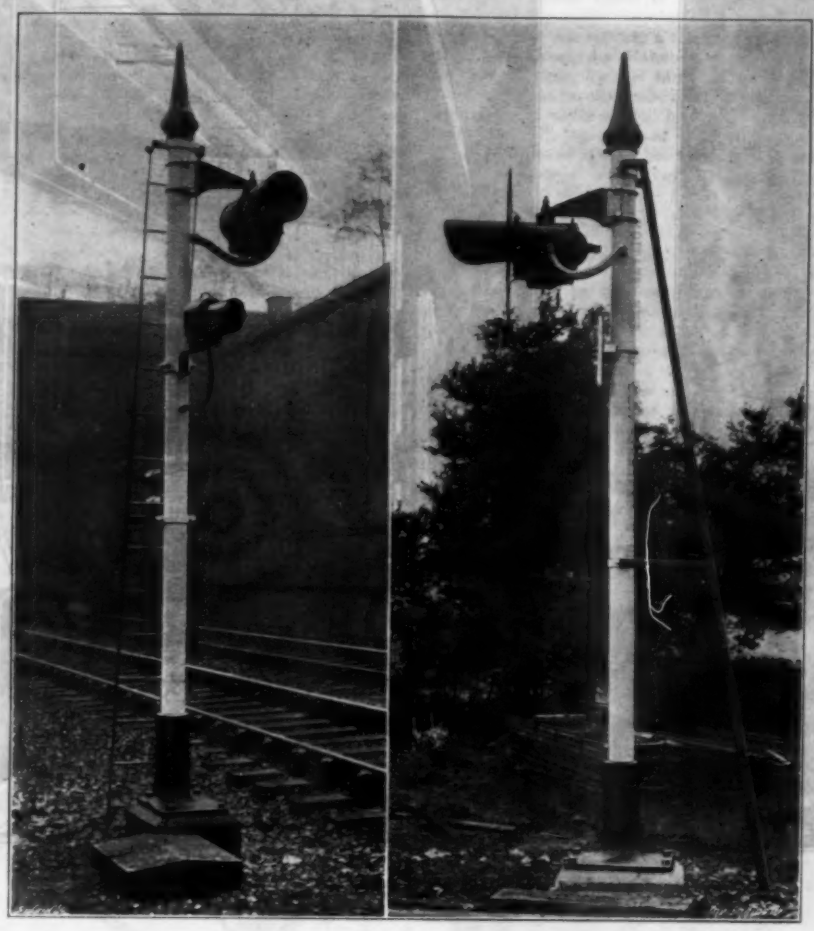
Day colour-light signals have been provided throughout—their first installation in this country excluding the Liverpool Overhead Railway and their first use here on a steam-worked railway. Experience has shown that even on days of the most brilliant sunshine these signals give very clear indications. As the express trains running over this section have necessarily to travel at high speed, except when leaving and approaching Marylebone, it is a satisfaction to know that the drivers are quite satisfied with the indications given.

Three-position signalling has also been adopted. Each signal gives the "danger" indication as soon as the engine passes, and it remains at that until the train has passed the next signal and the whole of the train has passed off the overlap in advance of that signal, *i.e.*, a full section plus its overlap. The red light then changes automatically to yellow, indicating "caution." When, now, that train passes out of the next succeeding section and off the overlap there, i.e., through two full sections plus the overlap at the beginning of the third section, the yellow light changes to green, intimating "clear." As laid down in the basis for this scheme a following train would, in a three minutes' service, now be approaching the signal we have been using as an illustration and the driver would find it at "clear." The next signal would, at this moment, probably be showing yellow, but if the preceding train was running normally that signal would give green by the time the driver sighted it.

It was very fitting that the contract for the work should have been awarded to the Westinghouse Brake and Saxby Signal Company, as that firm has specialised in and carried out the signalling on practically all the rapid-transit lines in this country which are provided with automatic signalling, and particularly in the Metropolis. This particular work is, however, unusual, inasmuch as the installation includes some of the Hall day colour-light signals. The Great Central Company had had one of these signals on trial for some months, and the new line gave an opportunity for a more extended test in actual use. On the whole of the installation there are twenty-two automatic or semi-automatic signals, and thirteen of them are of the Westinghouse Company's own type and nine are of the Hall type, obtained from the General Electric Company by the contractors.

A front view of the Westinghouse three-aspect day colour-light signal is given in Fig. 1 and a side view in Fig. 2. There is, it will be seen, a separate lens for each indication. The red is the lowest, the green the uppermost and the yellow is in the centre. The track-circuit controls are so arranged that the red, the yellow or the green lens is illuminated according to the condition of the two sections in advance, the electrical connections being such that only one indication can be given at one and the same time. A front view of a Hall signal is given in Fig. 3 and a side view in Fig. 4. The latter shows the background necessary in open country; the signal in Fig. 3 has the tunnel as a background. The latter has, it will be noticed, a lower, smaller lamp. This is exceptional; it carries a letter "A" which is illuminated when Marylebone Goods box is switched out, and thus tells a driver that he may treat the signal as an automatic. When the letter "A" cannot be seen, he knows it is being worked from the box, and must be respected accordingly. The

Hall signal has one lens through which a red, yellow or a green light is shown, as the condition of the tracks ahead determine. The respective colours appear as governed by a polyphase vane relay, which carries a frame containing a red, a yellow and a green glass. The vane is



FIGS. 3 AND 4—HALL THREE ASPECT DAY COLOUR-LIGHT SIGNALS

balanced so that the red glass takes the normal position, and it is suitably energised to move in one direction to take away the red glass and place the yellow in position, and in the other direction to display the green. There can thus, in this signal also, be only one indication given.

FIG. 5—SELECTIVE SPEED INDICATOR

With three-position signalling, the usual splitting distant signal indication at junctions—to tell the driver for which direction the home signal is lowered—cannot readily be given. This intimation is necessary at two places on the Marylebone–Wembley line—on the down line for going to High Wycombe or to Aylesbury at Neasden South Junction and for up trains approaching Marylebone Goods box to indicate when there is a clear road into the passenger station. This difficulty has been overcome by a new illuminated selective speed indicator—Fig. 5. This indicator carries two lamps, in front of each of which is a stencil cut with the alternate speeds in miles per hour. That seen in Fig. 5 is the one fixed 313 yards in the rear of the inner home signals at Marylebone Goods box, and is stencilled for a speed of 35 miles per hour in the upper lamp and 15 miles per hour in the lower. The lamps for lighting up the stencils are electrically controlled by the signals concerned so that, for instance, the outer home, inner home and starting signals for the Aylesbury direction at Neasden South must be at "clear" before the "25" in the indicator there can be switched out and the "50" switched in. This new feature should, we think, be found very useful by all railway companies, as at junctions only one distant need be provided, and, then, midway between the distant and the home signals there can be a speed indicator. This would be very beneficial in those cases where it is considered inadvisable to have a distant for leading through a connection that calls for reduced speed.

We regret that our space does not permit us to enlarge on those features that merit greater attention, nor to refer to the track circuit details—all alternating current, by the way. The most we can do now is to express our appreciation of the work done by the various officers of the Great Central Section—Mr. A. F. Bound, the signal superintendent, in particular—and by the contractors.

POWER SCRAPERS FOR HANDLING ORE.

For moving ore from mine workings to the chutes or "raises," through which it is dropped into trucks below, considerable saving in time, labour and cost has been effected in several American mines by the use of scrapers operated by cables on winding drums. Small compressed air winches with two drums side by side are used in this work. One drum operates the hauling cable attached to the bail of the scraper. The other drum carries the tail rope, which is led over a sheave or snatch block at the breast or heading and then back to the rear end of the scraper. Two men form the crew, the first operating the winch and the other trimming the breast, picking down loose ore and shifting the tail sheave as required. The scraper is usually a curved blade about 16in. wide and 3½ft. long, made of ¾in. plate and having its ends secured to a triangular bail formed by two steel angles. Its lower edge, sloping up 30 deg. from the horizontal, is sometimes fitted with teeth. Another form of scraper is a bottomless box about 3ft. square and 10in. deep, the back plate being inclined inward at the bottom and extending to a depth of about 16in. This is for soft material only, as in hard or coarse material the sides of the box will ride over the pile of ore. By means of a special releasing sheave the scraper can readily be operated around a right-angle turn. A winch with two drums 11in. by 5in. and 255ft. of ¾in. cable weighs 550 lb., and with 6½ horse-power on either drum at 75 lb. pressure it gives a speed of 110ft. per minute.

The New Barton Power Station of the Manchester Corporation.

The first half of the Manchester Corporation's new power station at Barton was formally opened yesterday, Thursday, by the Earl of Derby, who started one of the large turbo-alternator sets. The site of the station contains 14¼ acres, and is situated in Trafford Park, on the south side of the Bridgewater Canal in close proximity to the Manchester Ship Canal, from which water for condensation purposes will be drawn. In addition to this source of supply the sewage and subsoil water, in the form of a purified effluent, which passes down the main outfall sewer to the Davyhulme sewage works, will be available as an additional source of supply. The whole site is capable of ultimately accommodating 150,000 kilowatts of plant. The choice of site was a happy one, for the red sandstone rock underlies the whole of it at a depth of 6ft. to 10ft. below the surface, so that admirable foundations were obtainable. The Bridgewater Canal affords access to the west Lancashire coalfields, which are only 3 or 4 miles distant, whilst a siding connection to the Trafford Park railways provides through communication to all the principal railway systems in the country.

The general lay-out of the site is shown on the accompanying plan, Fig. 5, and a general view of the station is given in Fig. 2 on page 392. The first half of the station, which has now been constructed, consists of a boiler-house, 314ft. long by 87ft. wide and 86ft. high. Adjacent and parallel to the boiler-house is the turbine room, 243ft. long, 65ft. wide and 75ft. in height from the basement to the crane rails. The main transformer switch house, which is divided into three floors, is parallel to, but separate from, the turbine room, a passageway, 23ft. 6in. wide, separating the two sections. This passage provides access for the transformers to the cubicles. By roofing over the passageway accommodation is provided for the control room, station batteries, telephone room, &c. The main administrative offices abut on the eastern wall of the turbine room.

The buildings are mainly of steel framed construction, the walls being of brick in cement mortar and the outside facings of Burnley bricks with Accrington brick dressings. The sills, window heads and cornices are in concrete. The office building, with the feed tanks on the roof, is constructed of reinforced concrete with brick filling. The roofs of the main buildings are generally of lattice girder design, with lantern ventilators and covered with reinforced concrete slabs finished on top with rock asphalt. Fuel is delivered to the station either by rail or by canal, and storage is provided for 26,000 tons, of which the equivalent to a 65 hours' supply, or 3500 tons, is held in the boiler-house bunkers, the remainder being deposited on the storage ground outside. Both rail borne and water-borne fuel can be conveyed to the boiler-house bunkers, deposited in the store, or transferred from the store to the bunkers.

Coaling Arrangements.

A coaling dock with a lay-by has been constructed at right angles to the Bridgewater Canal and parallel with the easterly end of the buildings, the coal storage ground being between the dock and the coal viaduct. The dock is 50ft. in width and 395ft. long, and the storage dock is 243ft. long by 50ft. wide. Water-borne coal is delivered at the station in barges of 50 tons capacity, or in special box boats of 16 tons capacity. For the purpose of unloading two overhead travelling cranes, having a span of 75ft. 6in. between the rail centres, are carried on a gantry 63ft. above water level. The coal grabs have a capacity of 55 to 68 cubic feet of coal. When lifted by the cranes, the fuel is discharged into two hoppers which feed automatic weighing machines made by W. T. Avery, Limited, and situated outside the eastern end of the boiler-house before it is passed on to the boiler-house bunker conveyors. Alternatively, the water-borne fuel can be discharged into reinforced concrete hoppers, formed in the shape of cantilevers on the face of the dock wall and then fed on to the main silo conveyors for distribution on the storage ground.

The rail-borne fuel is delivered by a double track connection with the Trafford Park railways, storage siding accommodation being provided for about 180 full and 80 empty wagons. Both the full and empty wagons are passed over a self-contained weighing machine of 40 tons capacity. The coal viaduct is constructed of reinforced concrete and carries three tracks, one of which passes over the weighing machine and connects with the full sidings, the remaining two passing over the unloading hoppers and also connecting with the sidings. The railway wagons are discharged by tippers of the cradle type, placed between the rails over the hoppers and discharging at the bottom through a filler into the main distributing conveyors, which are of the gravity bucket type. In connection with the first section of the station eight lines of bucket conveyors have been provided.

The first two are styled main silo conveyors, and perform the following functions:—(1) The discharging of the rail-borne fuel into the boiler-house weighing or receiving hoppers; (2) the discharging of the rail-borne fuel on to the storage ground;

NEW ELECTRIC POWER STATION OF THE MANCHESTER CORPORATION AT BARTON.

MR. S. L. PEARCE, M. Inst. C.E., MANCHESTER, ENGINEER.

FIG. 1—EXTERIOR OF BOILER HOUSE

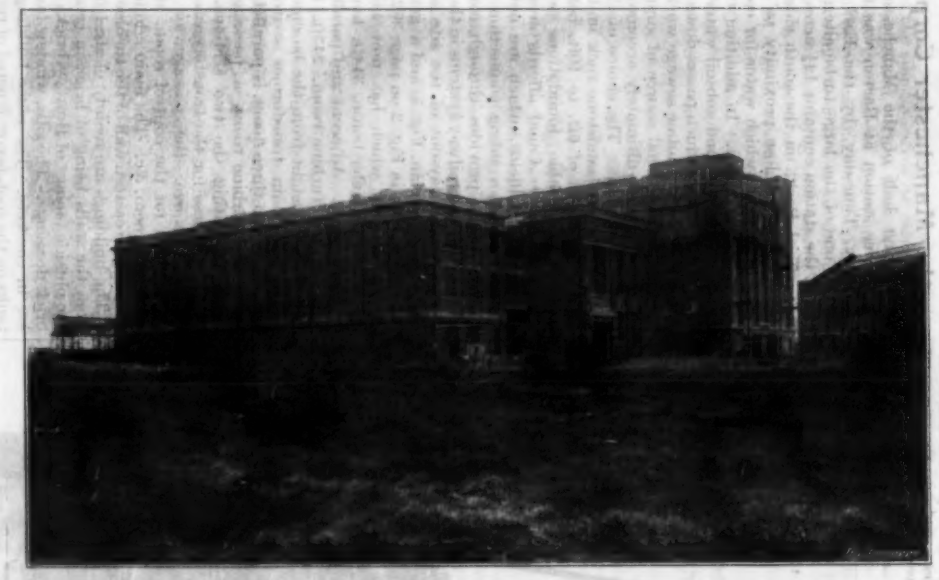


FIG. 2—GENERAL VIEW OF THE STATION

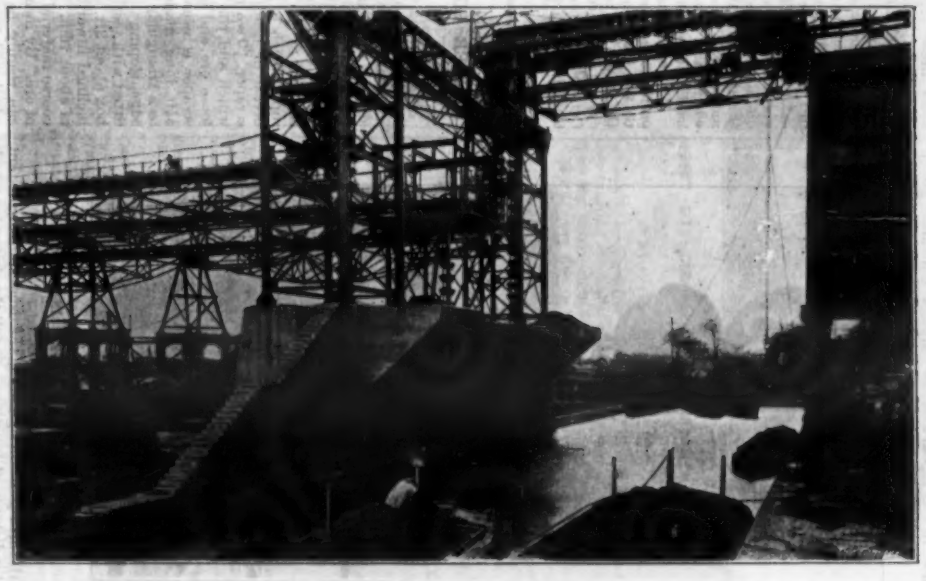


FIG. 3—UNLOADING WATER-BORNE COAL

FIG. 4—CIRCULATING WATER SCREENING PLANT

(3) the removal of the fuel from the storage ground and discharge into the boiler-house weighing or receiving hoppers; (4) the discharging of the water-borne fuel on the storage ground; (5) the discharging of the fuel into the cross conveyor feeding the intermediate silo conveyor; (6) the receiving of the fuel from the intermediate and cross conveyor referred to above for ultimate transference to the boiler-house bunkers. The third, or intermediate, silo conveyor is placed parallel to, and between, the main conveyors. The purpose of this conveyor is to distribute the coal on to the middle section of the storage ground lying between the two lines of main conveyors. Alternatively, it can receive coal from the storage ground for transference to the boiler-house bunkers. The fourth conveyor serves as a means of interchange between the two main silo conveyors. The remaining four conveyors are situated in the boiler-house, two lines being carried over each bunker. The bunkers are subdivided longitudinally to enable coal and other fuel to be kept separate. In connection with each of the two coal-weighing and receiving hoppers, an automatic weighing machine of 3 tons capacity for the canal-borne fuel, and a similar machine of a capacity of 30 cwt. for the rail-borne fuel are provided. The coal conveyors were constructed by W. J. Jenkins and Co., Limited; the electrical wagon tippers by Babcock and Wilcox, Limited; the coal grabs by Priestmans, Limited; the weighbridges by William Hodgson and Sons, Limited, and the coal cranes by J. M. Henderson and Co., Limited. A view of the water-borne coal handling plant is given on page 392.

The basement of the boiler-house is at ground level, and in this basement are provided two roadways, each of the standard gauge railway track, to enable the ashes and clinkers to be removed from the hoppers

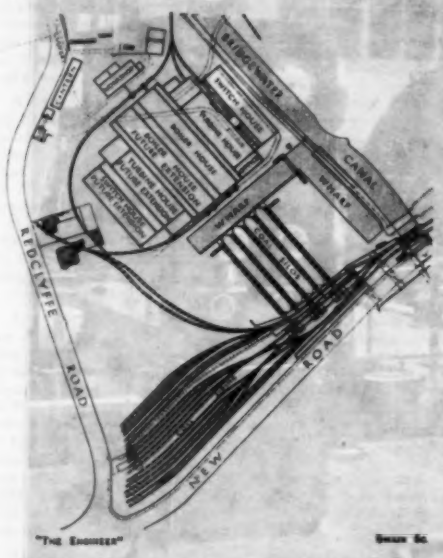


FIG. 5—PLAN OF BARTON POWER STATION

beneath the boilers, either by railway or road wagons, thus dispensing entirely with conveyors or suction ash plants. An ash hopper is also provided at the eastern end of the boiler-house for use at nights or week-ends when means of transport are not available, in which event bottom discharging wagons are employed, these being lifted and emptied by the coaling cranes.

Boiler-house Plant.

The steam raising plant comprises nine Babcock and Wilcox boilers, each capable of evaporating 100,000 lb. of water per hour—actual—at their most efficient rating when supplied with fuel with a calorific value of not less than 10,500 B.Th.U. They are also designed to evaporate 120,000 lb. of water per hour for overload periods, so that the total evaporative capacity of the boilers is over 1,000,000 lb. of water per hour. Each steam raising unit is complete in itself, and consists of the boiler proper, superposed steel tube economiser, integral superheater, air heater, chain grate stokers, mechanical forced and induced draught plant, and a steel chimney 9ft. diameter, with a height of 100ft. from the firing floor level. A grit arrester, made by the Dashper Patent Grit Arrester Company, Limited, has been fitted with each chimney. The plant is designed to work at an operating pressure of 375 lb. per square inch, and the superheaters are capable of imparting an additional temperature to the steam of 206 deg. Fah., making a final temperature of 738 deg. Fah. The boilers are fired from each end, and provision is made for feeding both coal and coke separately or together to the furnaces. The fans for induced or forced draught were made by Davidson and Co., Limited, and the fan motors by the Lancashire Dynamo and Motor Company, Limited.

Turbine House.

The principal dimensions of the turbine house have been already given, but it may be stated that the basement is 25ft. 6in. below the floor level and entailed the excavation to a depth of about 16ft. below ground level, the lower 9ft. being in red rock. In addition to furnishing space for the three main generating sets and three house service sets, the turbine house provides space for an unloading floor at the west end, where there is situated a pump room containing the main circulating pumps. Two cranes are provided, one having a maximum lifting capacity of 50 tons, made by Babcock and Wilcox, and the other of 15 tons, by the same makers. The turbine house walls are faced on the inside with red Accrington bricks with a white glazed brick dado, 8ft. 3in. above floor level. A skirting of blue Staffordshire brick 15in. deep is provided at the floor level, and two bands three-course deep at the top of the dado. The roof is constructed with lattice girder principals, and the lighting of the room is by means of a lantern, 34ft. wide and 5ft. high, at the eaves. The reinforced side of the office building forms the east end of the turbine room, and access to the offices and boiler-house is given by staircases on the gallery. The gallery is continued for about half the length of the north wall and gives access to the battery house, control room, cable passage and shift engineer's office, which are situated over the passage between the switch house and the turbine house. The floor of the turbine room is of concrete carried on rolled joist girders except where it is required to be removable. The floors are finished on top with Terratzo. The main turbo-alternating sets were supplied by the Metropolitan-Vickers Electrical Company, Limited, and are designed on standard lines operating at 6600 volts.

The pump house, containing the circulating pumps

FIG. 6—INTERIOR OF BOILER HOUSE

at the west end of the building, is 58ft. long by 34ft. wide, the floor level being 45ft. below the turbine house floor and about 36ft. below ground level. The circulating pumps are electrically driven, and of the centrifugal type made by Mather and Platt, Limited. The ordinary level of the Manchester Ship Canal, from which the circulating water is drawn, is about 9ft. 6in. above the floor of the pump house.

The turbine room of the first section of the station is designed to take three turbines of the Rateau impulse type, coupled to three-phase alternators, which run at a speed of 1500 revolutions per minute and each capable of delivering a maximum continuous output of 27,500 kilowatts at a power factor of 0.8, or 34,375 kilovolt-ampères. These turbines were built by Metropolitan-Vickers Electrical Company, Limited.

Each unit is designed to develop, at its most economical rating, the power corresponding to an output of 25,000 kilowatts, or 31,250 kilovolt-ampères, at the alternator terminals, and will carry for short periods a maximum load of 31,250 kilowatts, or 39,060 kilovolt-ampères. The normal conditions for which the turbines are designed are as follows:—Steam pressure at turbine stop valve, 350 lb. per square inch gauge; total temperature of steam at turbine stop valve, 700 deg. Fah.; vacuum at turbine exhaust at normal full load, 29.1in. One of the chief points of interest is the construction of the exhaust end of the machine, which is arranged on the now well-known multi-exhaust principle. Each turbine has fourteen stages and fifteen wheels, the fourteenth stage having two exhaust outlets from which the steam is directed in a stream-line path to the condenser. The size of the exhaust opening is 11ft. 2in. by 16ft. 2in. The total weight of each turbine is 170 tons. A "bleeder" feed-water heater forms part of the turbine equipment. It is enclosed in a compartment which extends across the turbine casing. The heater is exposed to steam drawn from one of the later stages of the turbine. The main alternators are designed for a pressure of 6600 volts, and are ventilated on the closed air circuit principle, an air cooler being provided to cool the circulating air. Each air cooler consists of two units situated beneath the alternator and enclosed by the foundations. The cooling water supply is obtained from the main condenser circulating water system, the amount required being 75,000 gallons per hour. The main condensing plants, made by Richardsons, Westgarth and Co., Limited, are each designed to maintain a vacuum of 29.1in. when dealing with 240,000 lb. of steam per hour, and provided with 45,000 gallons of circulating water per minute at an inlet temperature of 55 deg. Fah. Each condenser has a cooling surface of 40,000 square feet, made up of tubes 1in. diameter by 19ft. 6in. long. The tubes are made of Admiralty mixture and 18 S.W.G. thick. The condenser shell is made of riveted and welded mild steel plates with cast iron water heads and mild steel doors. The air extracting plant is in duplicate, one unit being a kinetic rotary machine, with two steam jets in series in addition to the water jet. The second unit comprises a steam ejector air pump of the three-stage type. These two plants are cross-connected, so that they can be run singly or operated together.

Power for the station auxiliaries is furnished from two sources, namely, three 1000-kilowatt 420-volt house-service turbo-alternators, by the British Thomson-Houston Company, Limited, and three 1000-kilowatt three-phase transformers stepping down from the main bus-bar voltage of 33,000 to 420. These turbines run at 3000 revolutions per minute, and the exhaust from them discharges into a heater through which the feed water passes on its way to the boiler-feed pumps. There are six boiler-feed pumps, and they are arranged in the basement of the turbine house. The normal duty of each pump is to deliver 600 gallons of water per minute against a head of, approximately, 1070ft. The whole of the feed system is arranged on the closed circuit principle—the condensate, after withdrawal from the main condenser, passes successively through the jet heaters, the main turbine bleeder heaters, the house-service turbine heaters, and the "Venturi" meters, to the boiler-feed pumps suction. A storage or buffer tank is introduced for balancing up the requirements of the boilers with the amount of condensate withdrawn from the main condensers. The small amount of make-up feed water required is introduced into the main condensers from the storage tanks after passing through a de-aerator. The circulating water is taken from the Manchester Ship Canal at a point about 450 yards above the bridge by which the Barton road crosses the canal, and is discharged at a point about 150 yards below the bridge. There is, therefore, between these two points, a length of canal of about 600 yards, which contains, approximately, 70,000,000 gallons of water.

Circulating Water System.

The intake and screening chamber was excavated to a depth of 26ft. below the normal water level of the canal, and about 50ft. below ground level. The depth of water thus obtained ensures a minimum depth of water of 11ft. in the chamber in the event of any accident to the gates at Barton locks,

which have a lift of 15ft. The width of the entrance to the intake chamber is 33ft. The water is drawn through three canals, each 7ft. 2in. wide, and fitted with inclined grid screens and travelling band screens, made by F. W. Brackett and Co., and shown in Fig. 4 on page 392. The intake culvert leading from the screening chamber to the suction sump is about 970ft. in length. It is circular in section, and 9ft. 6in. in diameter, and was built in tunnel at a depth of about 50ft. below ground level. The tunnel is lined throughout with brickwork, 9in. thick, in cement mortar, faced with red Accrington engineering bricks. Six electrically driven pumps have been installed in the pump chamber below the turbine house. Two units are, therefore, provided for each condenser. Each pump is capable of delivering 20,000 gallons of water per minute against a total head of 37.5ft.

After passing through the condensers, the water is discharged into vertical wells in the floor of the turbine-room basement, which communicate with the outlet culvert. This culvert is 1428ft. in length, 9ft. 6in. in diameter, and is of similar construction to the intake culvert. The outlet chamber is a closed chamber 100ft. long by 21ft. wide, the bottom level being 15ft. below the normal water level of the Manchester Ship Canal. A midrib, or weir wall, extends the whole length of the chamber and over it the water passes previous to returning to the canal, the discharge being made by ten openings at the bottom of the outer wall. The wall serves to distribute the flow along the whole length of the chamber, and also serves as a measuring weir.

Switch House.

The switch house is about 215ft. long by 52ft. 6in. wide, and a height from ground floor to underside of roof of 61ft. 9in., divided into three floors. On the ground floor, fronting the passageway which divides the whole building from the turbine house, are arranged the main step-up transformers, wherein the voltage of generation is raised to 33,000. The middle section of the ground floor is occupied by the pressure-testing plant, the main transformers oil-circulating pumps and water coolers, and the neutral earthing resistances. The remainder of this floor is allotted to the chambers for the trifurcating boxes for the main 33,000-volt feeders, which here pass down into the cable subway.

The first floor of the switch house contains the main and auxiliary bus-bars, isolating switches, current and potential transformers, &c., whilst on the second or top floor are all the oil switches, tie bus-bars and reactors. The whole of the switching is done at the full bus-bar pressure of 33,000 volts.

No switchgear is interposed between the 6600-volt and 33,000-volt circuits, as the generators are connected directly to their respective transformers through link switches only. Views of the top of the main oil switches and tie bus-bars, switch room, the main oil switch floor and the auxiliary switchboard are given in Figs. 8 to 11 on page 396.

Transmission and Distribution.

At the present time four feeders have been laid —each of 0.3 square inch section—for transmitting the Barton 33,000-volt supply into the Manchester area. In addition, the Lancashire Electric Power Company (which has entered into an agreement with the Manchester Corporation for a bulk supply delivered at the Barton bus-bars) has provided two feeders—each of 0.2 square inch section—for its requirements.

Two additional feeders of 0.2 square inch section have also been provided by the Stretford Urban District Council for a similar bulk supply arrangement. For receiving and transforming down the Barton supply, the following distributing stations have been erected in the Manchester area:—Stuart-street, Oldham-road, High-street (Chorlton-on-Medlock), Moss-side, Dickinson-street. It is of interest to note that High-street is the first example to be put down in this country of a complete outdoor sub-station operating at 33,000 volts.

Feeder Cables.

Each of the three-core feeder cables is equipped with copper tape protection under the lead sheathing in addition to the protection provided by the usual methods. The cables were laid direct in the ground, spare ducts being left for additional feeder cables, the whole of the work being protected by a cover of concrete slabs. The feeder joints were also enclosed in reinforced concrete outer boxes, run solid with pitch. Approaching the city sub-stations, owing to the congestion of other pipes and ducts, difficulty was experienced in providing accommodation for these feeders, and in numerous instances they had to be taken down below 15ft. in depth. Several canals, as well as streams, had to be crossed on the feeder route which necessitated special work either by tunnels or bridges.

Three hundred and fifty thousand yards of cable were laid underground on this contract, which required trench excavation of 72,000 cubic yards; mainly under roadway paving. The major portion of the work was executed in thirteen full working months.

The building work has been carried out by E. Nuttall, Sons and Co., Limited; the structural steel work by Sir William Arrol and Co., Limited; and the railway and road bridges by Francis Morton and Co., Limited. The oil coolers were supplied by the Power Gas Corporation, Limited, and the oil circulating pumps by the Pulsometer Engineering Company, Limited; the transformer chamber of ventilating fans by Matthews and Yates, Limited, and the 60-ton transformer truck by E. Wood and Co., Limited. The switchgear was supplied by the British Thomson-Houston Company, Limited, and the 420-volt distribution boards by Dorman and Smith, Limited. The two motor generators and two battery boosters were furnished by Bruce Peebles and Co., Limited. The 33,000-volt feeders and all the cable work in the station were supplied by Callendar's Cable and Construction Company, Limited. In the distributing stations, the transforming plant was supplied by Metropolitan-Vickers Electrical Company, Limited, and Ferranti, Limited, and the switchgear by the British Thomson-Houston Company, Limited, Reyrolle and Co., Limited, and Ferguson, Pailin and Co., Limited.

The consulting engineer to the scheme is Mr. H. N. Allott, M. Inst. C.E., and the whole has been carried out to the designs and specifications of Mr. S. L. Pearce, C.B.E., M. Inst. C.E., consulting and chief engineer to the Manchester Corporation.

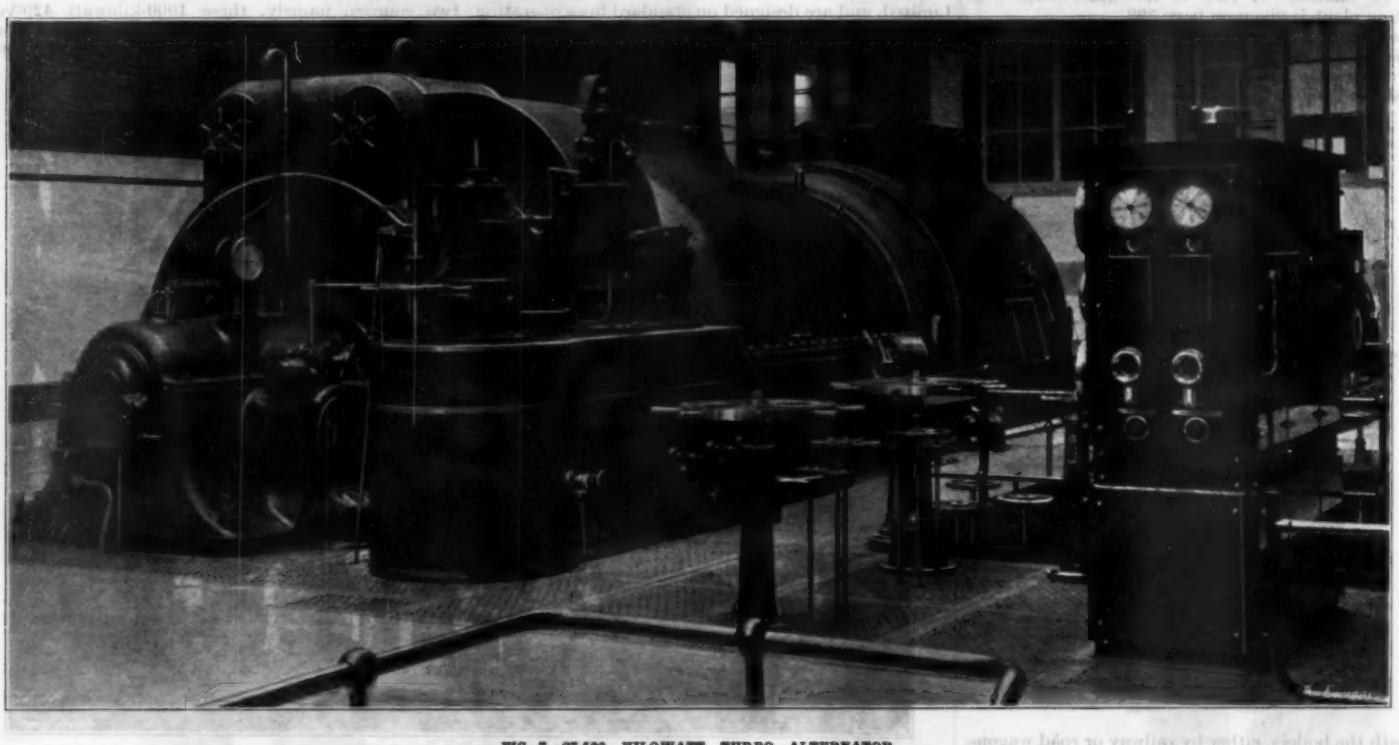


FIG. 7—27,500 KILOWATT TURBO-ALTERNATOR

LARGE MINERAL WAGONS.

The following letter has been addressed to South Wales colliery owners by Mr. F. I. C. Pole, general manager of the Great Western Railway. It is referred to in a leading article this week and will be read with interest:—

Under the Railways Act, 1921, the railway companies and the traders are directly and mutually interested in the efficient working of the railways. In considering ways and means of operating the traffic more economically, an outstanding point for consideration is that of increasing the carrying capacity of wagon stock.

For some years past the Great Western Railway have experimented with 20 and 30-ton wagons for general merchandise, but there are many difficulties in a country like Great Britain in using high-capacity wagons for this traffic, which passes in relatively small consignments.

As regards coal and mineral traffic—which constitutes roughly 70 per cent. of the total tonnage conveyed by them—the Great Western Railway Company are satisfied that there should be no further delay in introducing wagons of at least 20 tons carrying capacity. The advantages of a four-wheeled vehicle capable of carrying 20 tons of coal have been demonstrated from experience in using wagons of this capacity for the conveyance of locomotive coal.

The cost of constructing two 10-ton ordinary coal wagons is roughly 50 per cent. more than the cost of building a 20-ton wagon, and, as the census taken by the Board of Trade in 1918 disclosed that there were roughly 116,000 private owners' coal wagons in South Wales (mostly of 10 tons capacity), it is obvious that the introduction of 20-ton wagons would effect a very large saving in the annual cost of renewals. In addition, the necessity for more siding accommodation at the collieries and on the railway would be largely obviated, while the cost of repairs to wagons and sidings would be reduced.

In the interests of the trade of South Wales—where the practice in this respect is behind that on the North-East Coast—the owners of coal wagons are invited to commence the construction of 20-ton wagons as soon as possible. It is recognised that before any change can be made many difficulties have to be overcome at the collieries and at the docks; but the present is an opportune time to consider the proposal, in view of the fact that a number of traders are understood to be placing orders for the renewal of their rolling stock, while arrears of maintenance of tipping appliances, &c., at the docks are being taken in hand.

Irrespective of the initial saving in cost of wagon construction and the fact that railway operating economies will not accrue until a considerable number of high-capacity wagons are available, the Great Western Railway are prepared at once to allow a rebate of 5 per cent. off their rates in respect of coal class traffic conveyed wholly over their system in fully loaded 20-ton wagons.

Will you be good enough to let me know whether you are prepared to go into the matter with the company, in which case I will arrange for representative officers to wait upon you to discuss details.

A further trial of the electrically propelled barge, described in The Engineer of September 7th, was carried out at Kidderminster on September 28th. The Executive Committee of the National Council for Inland Waterways was present, and the results of the tests were, if anything, more satisfactory than those we have already recorded.

Railway Matters.

The up day Irish mail ran into the buffer stops at Euston Station on the evening of the 26th ult. Six passengers were injured.

The new jetty for dealing with China clay traffic at Fowey, erected for the Great Western Railway by Messrs. Spencer (Melksham), Limited, has recently been brought into use. The belt conveyor is electrically operated.

As from Sunday last, the 7th inst., the 16.30 (4.30 p.m.) express from London to Paris, *viâ* Dover-Calais, was restored, being due at the Gare du Nord at 23.25 (11.25 p.m.), the fastest train of the day.

The Compagnie Internationale des Wagon-Lits is providing some new first-class and second-class sleeping cars, which are first to run between Milan and Rome. The first-class cars will have only one berth; the second-class will have two berths.

One of the worst railway disasters of recent years in the United States occurred on the 27th ult. A bridge, in the State of Wyoming, on the Chicago, Burlington and Quincy, was weakened by floods and collapsed under a passenger train. At least two cars were submerged and fifty or sixty passengers are reported to have been drowned.

The demolition of an interesting landmark at Exeter Great Western station—the elaborately designed chimney of the engine-house, built when the line between Exeter and Newton Abbot was operated by the atmospheric system in 1847—is announced in the *Great Western Railway Magazine*. The building has been used as a retort-house for oil gas for train lighting, and the chimney is to be removed as it is unnecessary and needs extensive repairs.

A collision, so serious in its effect that the wreckage obstructed three lines of way, occurred on Friday morning last on the Midland section of the London, Midland and Scottish Railway between Sundan and Leagrave. Two up goods trains were involved. The newspaper reports of the accident do not specify whether the trains were travelling on the passenger or the goods lines. Some of the goods lines on the Midland section are not worked on the block system, and the trains in question may not have had that protection.

At the presentation of a fine silver loving cup from his former staff, Colonel Billington, the locomotive superintendent of the late Brighton Railway, spoke of the engine Remembrance, and said that when the men asked that that engine should have such a name in remembrance of those fallen in the war, it struck him as peculiarly appropriate in a double sense. Colonel Billington added: "It is a remembrance to the fallen, and it is a remembrance to me, as I think it is more than possible—I regret to have to say it—that it will be the last engine that Brighton will ever build. I regret to have to think of it, but I can see no alternative."

According to the recently issued Railway Statistics for April last, the tonnage of freight carried that month was 27.93 per cent. higher than in the corresponding month of 1922. The Ministry of Transport explains that whilst this increase was general, there was an advance of 133 per cent. in ironstone and iron ore. The ton-miles were 22.54 per cent. higher, despite the average length of haul falling from 53.11 miles to 50.87 miles. The freight receipts increased 1.68 per cent., but the receipts per ton-mile fell from 1.857d. to 1.541d. The freight train-miles were 16.9 per cent. more. The average train load was bettered from 126.62 tons to 134.18 tons, and the net ton-miles per engine-hour from 446 to 466.

An agreement under which the shop crafts employees on the New York Central will return to the piecework basis of payment has been concluded following lengthy negotiations between the officers of the road and the head of the Federated Shop Crafts. This agreement, which comes after years of dissensions, is the first since Federal control by which a United States railway labour organisation has approved the employment of its members under this system of remuneration. It is understood that the terms of the agreement were approved reluctantly by the union leaders, who accepted only because of anticipated approval of the piecework system by the Labour Board in the near future.

In this column last week we referred to a sitting of the Railway Amalgamation Tribunal on the previous Friday. It was a sad coincidence that on the day following the meeting, the Chairman of the Tribunal, Sir Henry Babington Smith, died. The work of the Tribunal is now almost completed. The cases of the Mid-Suffolk and the Leek and Manifold are to go to the Court of Appeal. They are insolvent companies, and the London and North-Eastern and the London, Midland and Scottish companies, respectively, questioned the judgment of the Tribunal and had intended to ask for a case to be stated. They, however, said, when the Tribunal met, that they would not do so. Mr. G. J. Talbot, the chairman, and his colleague, but Sir William Plenden, thought that it was better for the cases to go to appeal, and it was so ordered.

According to the Board of Trade returns, the value of the railway material exported during the first eight months of the present year was as follows, the corresponding figures for 1922 and 1921 being added in brackets:—Locomotives, £1,931,510 (£3,237,184, £5,133,369); steel rails, £1,568,199 (£1,796,625, £1,929,497); carriages, £692,448 (£1,122,712, £1,032,593); wagons, £1,971,204 (£2,313,497, £3,817,023); wheels and axles, £664,101 (£906,700, £1,290,165); tires and axles, £370,415 (£302,174, £964,144); chairs and metal sleepers, £576,179 (£1,583,433, £859,926); miscellaneous permanent way, £727,947 (£1,008,334, £1,839,384); total permanent way, £4,112,170 (£5,730,759, £7,059,599). The tonnage of the rails exported was 175,145 (176,645, 87,748), and of the chairs and metal sleepers, 51,223 (111,490, 35,326). Locomotives to the value of £76,352 were shipped during August alone to India, and of £76,793 to "other countries," i.e., neither to British possessions, South America nor Spain. Rails to the value of £57,143 also went to these unnamed "other countries," and of £35,550 to India, £26,038 to South Africa, and £17,735 to British West Africa.

Notes and Memoranda.

The Public Health Service of America has dropped the metric system from its specifications covering the purchase of drugs and medical supplies. The General Supply Committee of the Treasury Department has also adopted this procedure. The question of eliminating the metric system from specifications of other purchasing departments of the Government is understood to be pending.

To encourage technical education, John Thompson, Limited, boilermakers, of Ettingshall, Wolverhampton, have announced that technical appointments in the company will be open to youths in their service who acquire technical qualifications by their own exertions. In addition, as an inducement and to facilitate such studies, time will be allowed and full wages paid to those who attend classes. A university scholarship is also being offered for competition among the company's employees.

Writing from Spitzbergen to the Mayor and Coulson *Apprentices' Magazine*, Mr. Brierley says that "mining here is wonderful—good roof, no gas, no water, and a cold mine; everything in the mine is kept in a good state of preservation by the low temperature, which is at no time more than 28 deg. Fah., or 4 deg. of frost; in winter it is 10 deg. Timber never decays, cables and motors and switchgear never suffer from damp, and when not in use are stored in the mine. The seams are ideal for machine mining and conveying."

It is anticipated that the Capetown Port elevator and seventeen of the larger country elevators will be opened not later than March next, and seventeen of the smaller country elevators by about the following July, so that a considerable portion of the next South African maize crop should be handled in bulk through the elevators. The storage capacity of the port elevator at Capetown is to be 30,000 tons; of the thirty-three country elevators in maize areas, 106,600 tons; and of one elevator at Moorreesburg, a wheat centre, 2600 tons.

Crystalline areas in the nicked-bend fracture of a wrought iron bar do not, says the *Engineering News-Record*, necessarily indicate the presence of steel in the material from which the bar was made, nor do they indicate high-phosphorus iron. On the other hand, the presence of steel in the material of the bar does favour the formation of such crystalline areas, because it tends to produce uniform distribution and small size of the individual slag threads, and this latter condition is closely connected with the development of the crystalline areas. In such a test the crystalline areas developed on the tension side of the tested bar are more significant than those on the compression side.

A pressure of about 20 lb. per square inch was recorded, according to the *Iron and Coal Trades' Review*, in the experimental gallery at Eskmeals, when Silkstone coal was used, and almost instantaneously the flame travelled 350ft. along the inside of the explosion gallery and 150ft. outside the open end. Effective, however, as was this explosion, the pressure was much lower than that recorded when Arley seam coal was used. Then, on one occasion, 250 lb. pressure was recorded, but the maximum pressure inside the gallery was computed as being quite 500 lb. per square inch. In a further demonstration, using a mixture of 50 per cent. Silkstone coal dust and 50 per cent. Fullers earth, the mixture refused to explode.

The North End Bridge, connecting the city of Springfield and West Springfield, Mass., and having an estimated replacement value of 500,000 dollars, was, according to the *Engineering News-Record*, completely destroyed by fire on September 8th. It was built in 1878 and was of the Warren type, containing five spans. The fire, which it is believed started from a burning cigarette, was given great impetus by the fact that floor joists were tar-coated timbers supporting creosoted wooden block paving. Burning gas from a broken main hastened the bridge's destruction. Within ten minutes three spans had been entirely destroyed, and inside of an hour two of the remaining spans had fallen. The fire-fighters first drew water from a hydrant at a point where the pressure was so great as to burst the hose lines. At another point the pressure was too low to be of great service. The fa ling of high-tension wires also made the fire-fighting difficult.

A novel method of sorting steel by means of a spectroscopic equipment is described in a recent issue of the *Foundry Trade Journal*. The method is as follows:—One carbon steel bar is held in a suitable wooden frame, and the bars to be tested are then placed in position on the same frame as fast as possible, connection with the electric mains being automatically provided through a suitable resistance. The arc is struck by touching both rods simultaneously with a third rod of iron or carbon steel, insulated by slipping over one end a piece of ordinary rubber tubing. Removal of this rod strikes the arc, and the observer at the spectroscope is able immediately to state if the sample contains an important amount of nickel or not. Using three or four standard samples containing various percentages of nickel, the observer soon gets accustomed to state also the range of percentage within which the nickel content lies. Chromium and other metals lend themselves to equally simple detection with the same instrument.

The best method of drying out high-tension transformers is, according to the *Electrical World*, to apply heat to the transformer completely assembled and under oil. The whole unit may then be heated, the moisture being driven into the oil which is continuously dehydrated during the process. Heating is generally done by blanketing the tank, short-circuiting the low voltage winding and supplying sufficient potential to the full high voltage winding to give from two-thirds to full load current. This will require 3 or 4 per cent. of the rated voltage, depending on the impedance of the particular transformer, and such a value of voltage with suitable control is rarely ever available. Several days will be required to raise the temperature to a suitable value, and, since the coils will be very much hotter than the oil, great care is necessary unless the temperature is brought up very slowly. These methods require skilled attendance during the entire run, as resistance checks have to be made frequently and a little negligence may result in permanent injury.

Miscellanea.

The extension of the Birmingham tramway system from Selly Oak to Northfields has been opened, and it is hoped to complete the line to the Lickey Hills next spring.

Germany has increased the fees for registration of trade marks and patents, and has extended the terms of patents from fifteen to eighteen years.

Plans and specifications are being drawn up for a large steamer to ply out of Prince Rupert, British Columbia, to Alaskan ports, while an elevator and hotel are to be built there.

The outward service of the P. and O. company to Australia has been accelerated, so that the mails arrive at Fremantle on Tuesday morning instead of on Thursday. The passage will thus take twenty-six days.

A Bill which has been presented to the Chilean Congress has for its objects the provision of State aid to the iron and steel industry in Chile and the encouragement of foreign companies to work Chilean iron ore deposits.

The directing board of the International Hydrographic Bureau has recently submitted several proposals for the demarcation of the oceans and seas. The suggestions include the addition of two new names, the Scottish Seas and the Burma Sea.

An important irrigation project which has been started in Hyderabad will provide water for 275,000 acres, and will take about eight years to complete. A masonry dam, 115ft. high, is to be built across the river Manjra in connection with the scheme.

The committee which is investigating the electrification of the Swedish rural districts reports that in Oerebro Laen over 40 per cent. of the cultivated land is now supplied with electric power. The corresponding figure for Oestergoetlands Laen is 60 per cent., and for Kalmar Laen 15 per cent.

As a result of the recent reopening of the Trans-Siberian Railway to postal traffic, letters and postcards can now be forwarded to China through Siberia if specially superscribed by the sender for transmission by that route. Such correspondence should reach Shanghai in about twenty-four days.

Considerable deposits of limonite are reported to have been found on the Breconshire border at Ystradfellte and Penderyn. Tests have disclosed a seam 20in. thick, 20ft. from the surface. A second seam was found a little lower. It is believed steps will be taken immediately to develop the deposit for commercial purposes.

The first meeting of the North Wales and South Cheshire Joint Electricity Authority is being held to-day, Friday, October 12th, at 2.30 p.m., in the Council Chamber, Town Hall, Llandudno. The Vice-chairman of the Commissioners—Sir Harry Haward—will preside during the initial proceedings until a chairman has been appointed by the joint authority.

The latest traffic census taken in Sheffield shows that the two most important streets of that city carried 6,000,000 and 4,000,000 tons per annum respectively. It is noteworthy that in hardly any of the roads did the proportion of heavy motor vehicles fall below 50 per cent. of the total, while in one case it went as high as 78 per cent. Tramcars are not included in these records.

The recent postcard vote taken among the members of the Institution of Electrical Engineers having addresses in the London district, shows that the majority of those who voted were in favour of 6 p.m. for the Ordinary Meetings of the Institution, and it has accordingly been decided to continue to meet at 6 p.m. with light refreshments at 5.30 p.m.

The Secretary for Mines announces that in order to encourage the production of a safe and efficient type of electrical storage battery locomotive for use underground in coal mines, and with a view to displacing pit ponies in deep and hot mines, Mr. Charles Markham, colliery director, of Ringwood Hall, Chesterfield, has placed at his disposal the sum of £1000 to be offered as a prize for the best vehicle which fulfils certain specified conditions.

In commemoration of its seventieth anniversary, the *Warrington Guardian* was published as a twenty-four-page paper on October 6th. The *Guardian* was founded by Dr. Mackie, and was first issued on April 9th, 1853, price 5d. It was a success from the very first, and has prospered so well that it has now associated with it fourteen newspapers, covering a large area of South Lancashire and Cheshire. The anniversary issue is illustrated by a number of half-tone and line engravings, including one of the twenty-four-page rotary press, by Crabtrees, on which it was printed.

The announcement that a research is to be made into "cast iron to resist corrosion" has, says the British Cast Iron Research Association, been welcomed by a large number of members, showing the necessity of carrying it out. Interesting data have been sent in by members, from which it is evident that the purposes for which cast iron is required to resist corrosion are fairly large. They include piping, ship propellers, submersible motors, submarine junction boxes, electric heating apparatus, iron-clad and other switchgear for ship use, ship fittings, pumping plant of all kinds, condensers, turbine cylinders, parts of internal combustion engines, &c.

The British Chargé d'Affaires at Tokio reports that, according to a statement of the Japanese Minister of Foreign Affairs, it has definitely been decided to reconstruct Yokohama as a port, the damage to the harbour works having proved less extensive than was originally feared. It is understood that Yokohama will remain the port of export of silk from Japan. The Commercial Attaché to the Japanese Embassy in London has informed the Department of Overseas Trade that telegraphic information received from the Foreign Office at Tokio is to the effect that repairing work is already in progress at Yokohama, and it is hoped that by the end of October ordinary port facilities will be re-established. At Kobé, special arrangements have been made to deal with the congestion created by the diversion of vessels to that port, and the situation is improving.

NEW ELECTRIC POWER STATION OF THE MANCHESTER CORPORATION AT BARTON.

MR. S. L. PEARCE, M. Inst. C.E., MANCHESTER, ENGINEER.

(*For description see page* 391)

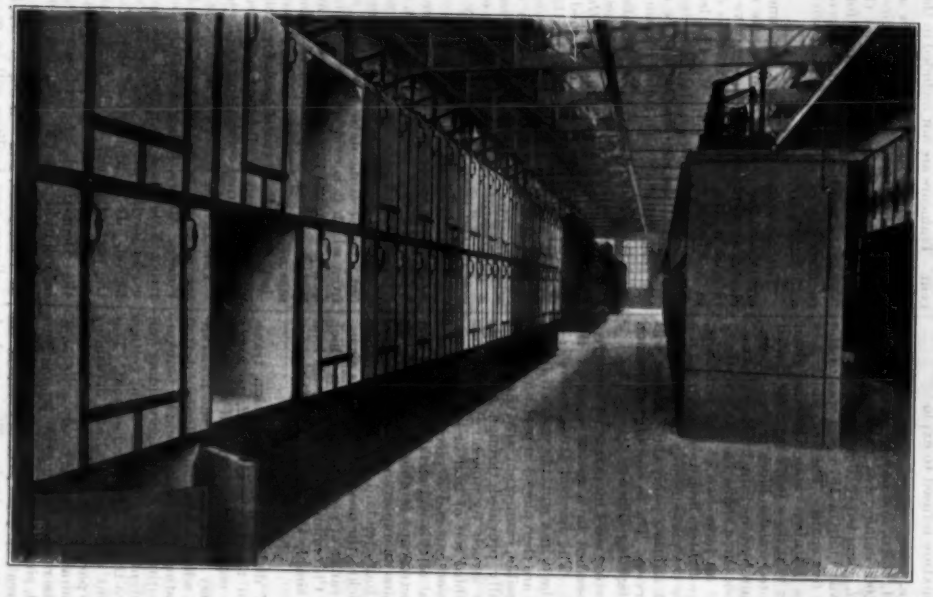


FIG. 8—MAIN OIL-SWITCH FLOOR

FIG. 9—TOP OF MAIN OIL-SWITCHES AND TIE BUS BARS

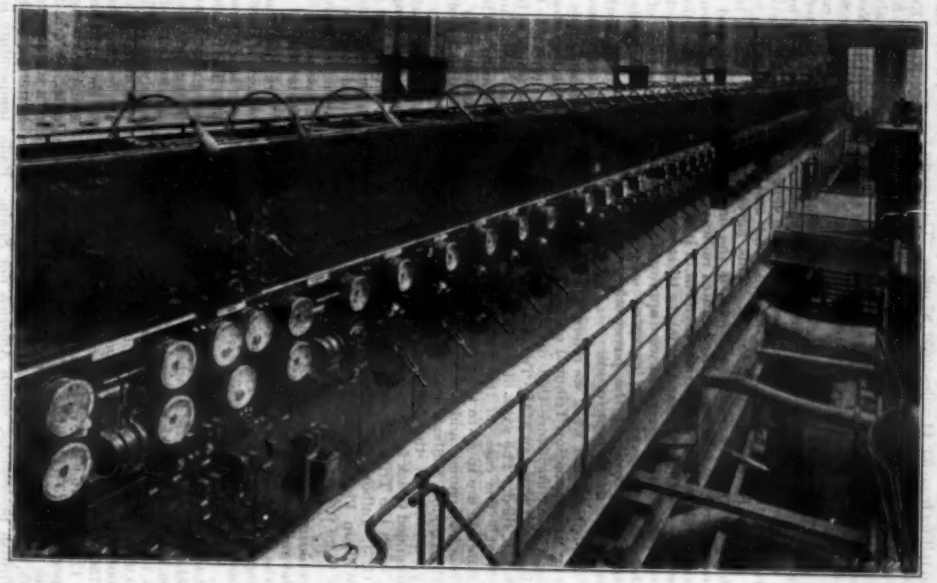
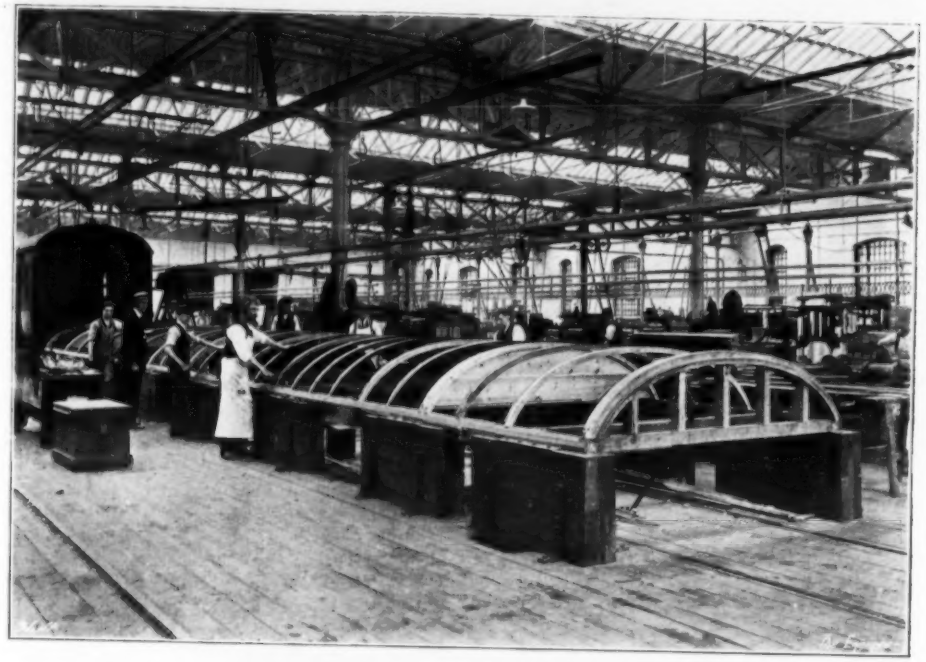


FIG. 10—AUXILIARIES' SWITCHBOARD

FIG. 11—CONTROL ROOM

LONDON, MIDLAND AND SCOTTISH RAILWAY—BUILDING CARRIAGE BODIES AT DERBY.

ASSEMBLING AND CRAMPING FLOOR FRAME



ASSEMBLING ROOF STICKS AND ANGLES ON JIG

FIXING AND CRAMPING DOWN ROOF

MAKING CARRIAGE END FRAMES

CRAMPING AND SCREWING DOORS

CRAMPING AND SCREWING QUARTERS

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

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PUBLISHER'S NOTICES.

*** *With this week's number is issued as a Supplement a Two-page Plate illustrating the Building at Derby of Carriage Bodies for the London, Midland and Scottish Railway. Every number as issued by the Publisher contains a copy of this Supplement, and Subscribers are requested to notify the fact should they not receive it.*

*** *If any Subscriber abroad should receive* The Engineer *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

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THE ENGINEER.

OCTOBER 12, 1923.

Notches and Scratches.

In principle at least, every engineer is aware of the danger of employing sharp notches in metal parts subjected to stress and more especially to alternating stress. But in practice the use of more or less deep notches having fairly sharp corners is often very convenient from the constructional point of view, and the temptation to allow such features to enter into design is so great that it is by no means always resisted. Keyways and even screw threads really constitute such "notches," and if either design or detailed workmanship is in any way at fault it is not uncommon to see failure originating at such corners. The remedy is, of course, to round all corners, but often the provision of a really adequate radius proves extremely inconvenient and may render design either unduly clumsy or even impracticable; none the less, the necessity for providing such a radius must be fully recognised unless a price is to be paid in the risk of failure.

There is, however, one very interesting consideration which arises here. The sharpest of corners is, in actual fact, provided automatically with some sort of "radius," two surfaces meeting in a true geometrical line being a mere Euclidean ideal which can never exist in practice. The question whether a notch or "corner" is dangerous or safe must therefore depend upon what the radius at the actual corner really is, the dangerous character of the corner increasing seriously as the radius diminishes. It would follow from this line of reasoning that even a shallow notch or incision, if it had an exceedingly sharp bottom radius, might prove dangerous. There is, in fact, a current belief that even a mere surface scratch, if sufficiently sharp, may prove a serious or at least an appreciable source of weakness, particularly under fatigue stresses. As a consequence of such belief, test pieces for fatigue machines, and even working parts liable to fatigue failure, have been carefully polished in order to remove such surface scratches. To the practical mind it is a little difficult to believe that it can make any serious difference to the strength and endurance of a massive piece of steel whether the surface is polished or left with an ordinary workshop finish. That rough tool marks may act as notches and produce stress concentration, particularly if they occur in parts whose general shape tends towards stress concentration, is more readily understood. But the value of actual polishing must be seriously questioned. Examined with sufficient care and a little magnification, any industrially polished surface is seen to be still covered with fine scratches, and if the notch-action theory could be rightly applied to such features the finer the scratch the greater its danger, since the radius at the bottom must be excessively small. In a perfectly brittle substance like glass, where no adjustment of stresses by the slightest degree of plastic flow is possible, such a theory may perhaps be applicable; but if it is, then the strength of the material can surely be relied upon only in the "scratched" and not in the truly polished state, since the latter could never be long maintained in any practical service. In metals, however, with the possible exception of the hardest of hardened steels, the conditions are decidedly different. Where a "notch" is so shallow as to be but a surface scratch, any great stress concentration near the sharp "radius" must lead, first of all, to a minute amount of plastic flow. If the "notch" is extremely shallow a correspondingly minute amount of yielding will allow the stresses to distribute themselves more uniformly; the excessively sharp radius will, in fact, disappear spontaneously under the action of stress, nor will there be any tendency for it to reappear even under a reversal of stress. Only when the notch is deep enough to make a much greater amount of flow necessary for "rounding out" the corner do we attain working stresses high enough to cause rupture if the radius at the corner is very small. The deeper notch, to begin with, tends to produce a general concentration of stress near its end, and if to this is added a special local concentration due to a sharp corner or minute radius, a state of affairs specially favourable to rupture is brought about. The sides of such a deep notch, while themselves not under serious stress, resist the tendency of the heavily stressed metal to flow in such a manner as to round out the corner and indeed fracture may be regarded as the result of this resistance to flow of heavily stressed metal. It is here, if designer or workman or both have allowed a sharp corner to creep in, that we must rely on the ductility of the metal. Broadly, since the resistance to fatigue is now well known to increase with increased tensile strength and hardness, there is a reasonable desire to use the harder materials where fatigue has to be encountered. Where this practice is followed, however, the matter of notches and sharp corners must be given very minute attention if disappointment is not to result. A feature of design of this kind which would have given no trouble in a mild steel of good elongation is apt to give rise to failures when a heat-treated alloy steel of very high tensile strength is employed, and it seems likely that the failures sometimes ascribed to alloy steels are really due to some such cause as this.

This whole question of the adaptation of design, both in its broad outlines and in minute detail, to the characteristics of the material to be used, is one of increasing importance. The range of engineering materials is steadily widening, but at first, when any new material is introduced there is always a strong tendency to use it in precisely the same manner and even in the same form as the old familiar material. The ancient Egyptian constructor who, on passing from reeds and leaves to baked brick and then to carven stone, still maintained the reed forms in his buildings, finds a counterpart, to a certain extent, even among modern designers. The careful as well as progressive engineer, however, will study the peculiarities of any new material very thoroughly, and one of the features which it is particularly important to examine is this behaviour in regard to notches or even scratches. For, although mere surface scratches are of no serious effect except on glass-hard materials, yet something not much more than a scratch—such as a slight tool mark—left in the designed radius at a corner may make all the difference between failure and success.

High-Capacity Wagons.

The action taken by the general manager of the Great Western Railway in addressing a communication to colliery proprietors and others who own their own rolling stock, with the object of securing their co-operation in an effort to introduce larger wagons for the conveyance of coal, will doubtlessly bring once more the question of high-capacity cars into prominence. It is a subject, of course, which is by no means new. It has been discussed this way and that for a number of years, but as yet little progress, save on one railway, the old North-Eastern, has been made in introducing what is in itself one of the simplest means available for reducing expenses in the carriage of a commodity of which many thousands of tons are moved annually over the railways. We learn

from Mr. Burtt's recently published book, entitled "The Principal Factors in Freight Train Working," that the average carrying capacity of North-Eastern mineral wagons was 10.06 tons in 1901, 12.76 in 1910, and 14.00 in 1921. It is sometimes assumed that the retention of the small mineral wagon in this country is due to mere obstinacy, but it may safely be said that, were that the only obstacle to the adoption of large wagons, it would have been overcome long ago by the demonstrable advantages. As a matter of fact, owners have been able to make out such a case for the smaller type that a few months ago a standard type of 12-ton wagon was agreed to by the railway companies acting in conjunction with representatives of the owning interests. We will not say that this action has delayed the coming of the bigger wagon. But it was a recognition of the present needs and shows that any rapid turnover to the larger type is improbable.

Our railway companies have themselves used for some years wagons of greater than average capacity, notably for the carriage of locomotive coal, and a large number of 20-ton wagons—many of them, we believe, fitted with one or other of the continuous brakes—are so employed. If during this time loading plant at collieries and coke ovens, and unloading arrangements at blast-furnaces, steel works, electric power stations, docks, and other places, had been gradually fitted to deal with the larger wagons, and the many new or comparatively new loading and unloading appliances which have been brought into use had been constructed with future requirements in view, most of the difficulties complained of would not exist. We recognise fully that wagons of larger size than those now in service would offer relatively little advantage so far as general merchandise is concerned. Consignments are in many cases small, and the variation in the specific weight of the commodities handled under this heading is important. The average load carried by general freight wagons is far below the weight for which the vehicles are plated. But where materials such as coal, coke, ore, and others can be, and actually are, dealt with in bulk, then the high-capacity wagon has qualities that cannot be questioned. In our issue of the 5th inst. we mentioned an order recently placed in this country by the railways of the Union of South Africa for eight-wheeled cars having a capacity of 40 tons. They are designed for grain traffic and will, we suppose, in conformity with usual practice, be fitted with the continuous brake, in this case the vacuum. Here is an object lesson from one of the world's youngest railway systems. On the Great Northern section of the London and North-Eastern Railway several 50-ton eight-wheeled wagons are in use for the conveyance of bricks; we understand that they give every satisfaction. They are marshalled at the front of the trains in which they are used, and, being "fitted," are much liked by the enginemen, who feel they have a good control of their train, especially going down the bank from Potter's Bar to London.

We do not yet expect 40 or 50-ton wagons to be generally used, but to ask for four-wheeled 20-ton vehicles fitted with the brake is not extravagant. The advantages are many and various. They result in a saving of considerable engine power, savings in shunting and in siding accommodation may be expected, and from an owner's point of view their first cost is less for a given load capacity; in fact, Mr. Pole states that one 20-ton wagon can be built for about two-thirds the cost of two 10-ton wagons, or, in other words, two 10-ton wagons cost approximately 50 per cent. more than one of 20 tons capacity. There is also a saving in maintenance cost, since one wagon can be run for less than two. As there are well over one hundred thousand owners' wagons, mostly of 10-ton capacity, in the South Wales area alone, the possible saving is very great. There are only four tires to be turned up instead of eight, and only four axle-boxes to be oiled instead of eight, and so on. These advantages and others are important, and should be worth attention. Moreover, with the added inducement of a rebate of 5 per cent. off the rates on coal traffic conveyed wholly over its system in fully loaded 20-ton wagons, as offered by the Great Western Railway,—possibly as the result of a suggestion made by Mr. Gresley in a paper read before the Institute of Transport and reported in our issue of February 9th last,—they should help to set on foot a movement which may eventually lead to the use of modern all-steel high-capacity wagons fitted with continuous brakes.

Research Associations.

There are now twenty-two research associations actually at work under the Department of Scientific and Industrial Research. When the "Million Pound Fund" was established by Parliament in 1917–18 it was stipulated that it was to be used, in part, to supplement funds found by trade associations established for the undertaking of research. Payments were to be made over an agreed period, which was fixed in all cases at five years, and in general the grants were awarded on a pound-for-pound basis. One research association, that established in connection with the photographic industry, has now been in existence more than five years, and others are approaching the completion of the period during which grants are payable.

It was originally hoped that before the five years had expired each research association would be self-supporting, that the industry to which it was attached would be able to bear the full burden of the expense involved in continuing its activities. That anticipation has not been realised, largely—though apparently not wholly—because of the industrial depression of the past three years. The slump came before any of the associations had emerged from the costly formation period. The Department has thus been compelled to review the situation in order to determine whether and what farther financial assistance should be given to the associations after their five-year periods have expired. It has now decided to follow a set practice in the matter. With the assistance of independent technical experts, the Board of Trade, and its own officers, it proposes to institute an inquiry into the scientific, economic, and administrative aspects of the operations of any association applying for extended assistance. Should that inquiry reveal a satisfactory position, the Department will proceed to fix what it intends to call the "effective income" of the association; that is to say, the income required by it in order that it may continue its work in a manner adequate to retain the confidence and support of its industry. Should such effective income be more than can be immediately expected from industrial contributions, the Department will make a new agreement undertaking to continue the payment of grants over an additional period not exceeding five years. It is intended that the new grants shall be made of annually diminishing value in order that when they cease the association shall not experience a sudden change on reaching the self-supporting stage. In the case of the Photographic Research Association inquiry showed that a considerable measure of success had been achieved, but that the Association, during the five years of its existence, had suffered from certain disabilities over which it had no control. The Department has determined that the Association's effective income is about £6000, and proposes to extend its grants in this case over the next four years. It is not stated to what extent the Department's financial assistance will be given or in what manner it will be graded down from year to year.

Reading between the lines of the reports for this and previous years issued by the Committee for Scientific and Industrial Research, it is apparent that the intention is to tighten up the control over the research associations receiving assistance from the Government. It is well known that, while some of the associations are active and progressive, others are languishing from various causes, of which internal rivalry, individuality and independence of thought are not the least important. In homely words, the position is that if an industry will not do its best to help itself, it will find its research association at the end of the five-year period given a cold shoulder by the Government. The idea that the nation's money would be permanently available for the assistance of research associations has encouraged some firms to do less than they should or could do to help in their organisation and running. Actually the Government's share in the scheme is confined, and rightly so, merely to assistance during the period of establishment, and is only being continued beyond the agreed five years in those cases in which the establishment has been faced with unmerited difficulties. From now onwards will be the true testing time of the research associations. In not a few instances they are being very actively supported by their industries and have already much more than justified their establishment and continued existence. In others, however, it is known that the industrial support accorded is half-hearted and the useful work so far done of little importance. Such associations, it is now clear, are not to be allowed to drag along indefinitely in a moribund condition. The firm standpoint which has been taken up in this matter by the Department should be welcomed by all having the progress of scientific and industrial research in this country at heart.

Scientific and Industrial Research.*

The report of the Committee of the Privy Council for Scientific and Industrial Research for the year 1922–23, just published by H.M. Stationery Office, includes, as usual, a report submitted to the Committee by its Advisory Council. In previous years it has been our custom to reprint the Committee's report practically in full, and subsequently to publish extracts from the more technical and detailed report of the Advisory Council. Growth in the Department's activities renders it necessary this year that we should omit the Committee's report. What follows is therefore a summary of the Advisory Council's report, together with any appropriate remarks or comments to be found in the Committee's report under similar headings.

Finance.—The estimated cost of the Department's research programme for the current financial year is £281,424, or £24,938 less than in 1922–23 and over £281,000 less than the original estimate for 1921–22. The saving effected as compared with two years ago has been achieved by a reduction in the civil service bonus, by curtailment of expenditure at the National Physical Laboratory, by reducing the expenditure on researches carried out elsewhere than at Teddington, by postponing a proposed purchase of radium, by passing on to the fighting services the expenditure on research work specially undertaken for them, and by other means. The Council is of opinion that further reduction of expenditure would defeat the attainment of economy by preventing the Department from exercising effective co-ordinating control over Government research.

Research Associations.—The position with regard to the continuation of the Government grant to research associations subsequent to the expiry of the quinquennial period during which assistance is being afforded, is dealt with separately in an article on this page. During the year a research association was set up by the flour milling industry, the only new association formed since July, 1921. Many other prospective associations have been under discussion, including associations for the liquid fuel, shipbuilding, aircraft, agricultural machinery and grinding plant industries; but while some seem likely to be formed, others have been put aside. Meanwhile, the million-pound fund has been largely hypothecated, so that it is essential for those interested in the formation of any new association to bring matters to an early conclusion if they desire to benefit by that fund.

Fuel Research Board.—During the year Sir George Beilby resigned his position as Director of Fuel Research, and in his place Sir Richard Threlfall was appointed Chairman of the Board and Dr. C. H. Lander, Director of Research. The growth in the work of the Board has made it desirable to set up a number of panels, each dealing with the aspects of interest to a particular industry or group of industries. It is hoped, too, that it may soon be found possible to increase the staff under the Board to double or even treble its present size. Among the investigations conducted by the Board during the year was one on the carbonisation of seaweed, with a view to reviving the seaweed industry on the Atlantic coast. A report on this subject is being prepared. The physical and chemical survey of the national coal resources has been extended by the work done by the Committee for the Lancashire and Cheshire area. The data obtained for this area are, however, less complete and less reliable than the corresponding information that has been published in connection with the Yorkshire, Nottinghamshire and Derby areas. The Committee on the Sampling and Analysis of Coal has presented a report on methods of analysis, and has recommended a standard procedure; but it has still to deal with the difficult problem of sampling. The preparation of power alcohol by the acid hydrolysis and the fermentation of cellulose material has been studied further, and manufacturing scale experiments are about to be undertaken in order to study the economics of its production from African grasses. The report mentions "Discol," the liquid fuel now being made in this country by the Distillers' Company, Limited, and states that it is composed of 50 per cent. denatured alcohol and 50 per cent. "of a blend of hydrocarbon spirits."

Geological Survey.—The staff engaged under the Geological Survey Board has now been enlarged, and seven field units have been engaged in various parts of the country on primary 6in. survey or coalfield revision work. Somewhat late in the day, the report makes mention of the almost accidental discovery of bauxitic clay at Saltcoats on the Ayrshire coast. Tests showed that this material was distinctly different from other fire-clays found in the district, and that it had a very high refractory quality. It was found

* Abstract of report for 1922–23 submitted to the Committee on Scientific and Industrial Research by its Advisory Council.

to be difficult to handle, by reason of its lack of plasticity, but this drawback being overcome, a great demand for the clay sprang up, especially for making bricks for electric steel furnaces. The discovery proved very fortuitous during the war, for it enabled British manufacturers to provide a substitute for certain refractories previously obtained from Germany. It has led to the establishment of a new industry in Ayrshire, namely, the manufacture of both refractory bricks and alum.

Forest Products Research.—The Forest Products Research Board has now surveyed the wide field of work entrusted to it. It is proposed to study, among other matters, the preservation, testing and seasoning of timber. For the latter purpose, an equipment of drying kilns is to be set up at the Royal Aircraft Establishment, Farnborough. The Research Board will pay special attention to British-grown timber and to the vast overseas reserves available within the Empire.

Building Research Board.—The Building Research Station at Acton has been in full operation since it was opened in July, 1921. During the past year much attention was devoted to fundamental research work on cement. The aspects studied included the hardening and setting of cement, the effect of excess of sulphides in blast-furnace slag cement, and the effects of high magnesia and high alumina in cements. The Board also conducted an investigation into magnesite cements as used for making "jointless" floors, and made a successful effort to produce such a cement without its chief objectionable characteristic—its corrosive action on metals in contact with it. Among other work now in hand is an investigation into the decay and preservation of stone and another on the economical use of fuel in brick-burning.

The Co-ordinating Research Boards.—The work of the Co-ordinating Research Boards—the bodies established to promote co-operation between the different Government Departments and outside organisations in the conduct of research of common interest—is stated to have shown increasing value during the past year. It is indicated, however, that the Chemistry Research Board is being handicapped in its work by the lack of sufficient and suitable facilities for research, and that additional accommodation is greatly needed. The other Boards, such as the Physics, Engineering and Radio, find the existing Government facilities for research ample at present for their work.

The Physics Co-ordinating Research Board has paid much attention to acoustical signalling, and, in particular, co-operated with the Admiralty in experiments at St. Margaret's Bay, having for their object the fixing of a ship's position at sea by the radio-acoustic method. The results were so satisfactory that the Board recommended that a trial should be made on a commercial scale, and that a small radio-acoustic station should be established at Niton in the Isle of Wight. This scheme has, however, been postponed for the present, as difficulties arose in applying the method to passenger vessels. The work now being conducted by, or under the control of, the Physics Board includes an investigation into the standardisation of yellow glass for signal lights, a subject in which the Ministry of Transport and the Air Ministry are interested.

Under the auspices of the Engineering Co-ordinating Research Board, a large amount of work has been done or is in progress in connection with the fatigue of metals. Under this heading we note that Mr. N. Thomas, working in Professor C. F. Jenkin's laboratory, has been investigating the effect of scratches and of various workshop finishes on the fatigue strength of steel, and has found that the effects are not so great as had previously been supposed. With the object of discovering a metallic coating which would protect from corrosion the aluminium parts of aircraft, a research was begun by Professor Desch on the electro-deposition of cadmium and other metals upon aluminium. It was found that the increase in weight represented by a suitable covering was prohibitive, but the results obtained were of sufficient general interest to warrant the Board to continue the investigation. Among the work now being conducted under the Board is a research into the best methods of protecting machinery in store from rust. In this connection, a programme of tests of certain rust preventives is to be carried out by the National Physical Laboratory.

Stresses in Railway Bridges.—As a result of representation made by the British Engineering Standards Association, a sub-committee of which is preparing a standard specification for girder bridges, a conference was called to consider the question of undertaking further work on the investigation of impact stresses in railway bridges. Following the report of the conference, the Advisory Council recommended that a Committee of the Department under the chairmanship of Sir Alfred Ewing should be set up to conduct researches on the subject. The investigations, it is expected, will extend over a period of about two years, and will cost some £17,000, more than half of which will be contributed by the railway companies of Great Britain. It is intended that a sum of £2000 shall be set aside to cover the cost of mathematical and laboratory investigations designed to develop the theory of the matter.

Assisted Researches.—In reporting the progress made by outside institutions conducting researches with financial assistance from the Department, the place of honour is given to the ferrous alloys research now being arranged by the Institution of Mechanical Engineers. The investigation is to be conducted by means of a fund, half of which will be supplied by the Department and half by outside sources. It is stated that the arrangements made for the building up of this fund are now in an advanced stage. In the case of other assisted researches, the report contains a strong hint that the Department views with disfavour the continuation of certain investigations with its assistance and without the adequate support of those to whom the results arrived at will be chiefly beneficial. In this category falls the Institution of Civil Engineers' research into the deterioration of structures exposed to sea action. The Institution has been asked to review the position of this research, to form an estimate of the probable cost of bringing it to a conclusion, and to endeavour to seek additional support from harbour authorities and other bodies likely to benefit from the results arrived at. Similarly, the research work undertaken by the Liverpool Tidal Institute should, it is recommended, now be provided for by contributions from the shipping industry. The Advisory Council is not prepared to recommend further grants to the Institute for the purpose of its investigation. The steam nozzle research of the Institution of Mechanical Engineers, hitherto carried on with the aid of grants from the Department, is now being brought to a conclusion by means of funds entirely supplied by the Institution.

Literature.

The Deterioration of Structures in Sea Water. London: Published under the authority of H.M. Stationery Office and to be obtained at Imperial House, Kingsway, London, W.C. 2; 28, Abingdon-street, London, S.W. 1; York-street, Manchester; 1, St. Andrew's-crescent, Cardiff; or 120, George-street, Edinburgh. Price 3s. 2d. post free.

Our readers will remember that a committee appointed by the Institution of Civil Engineers has for some time now been engaged on an investigation into the deterioration of structures of timber, metal and concrete in sea water. The committee issued a first report in 1920 and a second (interim) report in 1922. These reports were reviewed in our issues of January 21st, 1921, and June 16th, 1922, respectively. A third (interim) report has recently been published by the Department of Scientific and Industrial Research, from which the committee has received certain grants in aid. It is edited by Mr. P. M. Crosthwaite, B.A.I., M. Inst. C.E., the secretary to the committee, and Mr. Gilbert R. Redgrave, Assoc. Inst. C.E., and consists, first of all, of a covering report by the committee itself and then of summaries of a series of subsidiary reports sent in by observers in various parts of the world who are carrying out investigations under the direction of the committee.

In its main report the committee first of all records with deep regret the death of its first chairman, Sir William Matthews, which occurred on January 8th, 1922. It then goes on to detail what was done with the specimens of steel and other metals which were prepared at Messrs. Hadfields' works in order to test the action on them of sea water and of the atmosphere during long exposure. It is explained that these specimens, after being carefully marked, were packed in tin-lined cases and sent to various selected harbours, namely, Plymouth, Auckland, Colombo, and Halifax, Nova Scotia. The latter place, it is explained, was chosen as having winters of exceptional severity, Colombo and Auckland being typical of warmer climates, and Plymouth representative of a British seaport. All the samples safely reached their destinations and were exposed to the action of sea water in accordance with a specially designed plan which was followed by all the observers.

The committee then refers in turn: (*a*) to the replies it had received to a questionnaire which it had addressed to shipowners, railway companies, and large users of paint and other protective coatings employed for the preservation of steel and other iron structures exposed to sea action, and explains how that these replies had been considered and analysed by Dr. J. Newton Friend, whose report thereon is included in the present volume; (*b*) to a series of experiments carried out by Dr. Newton Friend on the influence of strain upon the incorrodibility of iron and steel; (*c*) to some special experiments which have been carried on by Professor S. M. Dixon on a large number of specimens of timber received from colonial and other correspondents; (*d*) to the biological investigations which were carried out during the past year by Mr. Harington under the direction of Dr. Barger; (*e*) to some tests carried out by Mr. W. H. Harmer, M. Inst. C.E., Engineer to the Auckland Harbour Board, on various native and other timbers, including lignum vitæ and puriri; (*f*) to a note contributed by Mr. E. A. Cullen respecting the condition of the reinforced concrete test blocks which where placed in position in the Brisbane River in November, 1917; (*g*) to an account given by Mr. A. C. W. Fosbery, the Chief Engineer of the Bombay Port Trust, of the condition of some steel gates recently removed from Prince's Dock, Bombay, after being in position for over twenty-four years; (*h*) to a report received from Mr. Cunningham, the inventor of the carbo-teredo process for the preservation of timber exposed to sea action, on "Boring Organisms in Various Waters;" and (*j*) to the fact that a copy of the report for 1921 of the San Francisco Bay Marine Piling Committee had been received from the president of the American Wood Preservers' Association.

Following the main report is an explanatory note setting out how the steel specimens referred to above were marked and despatched to their destinations, together with a copy of the instructions which were forwarded to the engineers of the various ports concerned. Then there are given abstracts of reports from Mr. L. H. Savile, M. Inst. C.E., Civil Engineer-in-Chief to the Admiralty, concerning the placing of the specimens at Plymouth by Mr. A. A. Williamson; Mr. H. H. Hamer, of Auckland; Mr. A. D. Prouse, M. Inst. C.E., Engineer to the Colombo Port Commission; and from Mr. C. E. W. Dodwell, M. Inst. C.E., Harbour Engineer at Halifax, Nova Scotia; and abstracts of the reports from the various investigators mentioned in the main report.

The whole forms a useful addition to the existing literature on the subject, and also most interesting reading. The committee is engaged on an excellent work and, to all appearances, the lines on which it is working should produce some very valuable results.

BOOKS RECEIVED.

Mechanics of Machinery: Mechanism. By R. C. H. Heck. London: The McGraw-Hill Publishing Company, Limited, 6 and 8, Bouverie-street, E.C. 4. Price 25s.

A First Course in Machine Construction and Drawing. By T. M. Naylor and W. Tattersall. London: H. F. and G. Witherby, 326, High Holborn, W.C. 1. Price 6s. net.

The Hydraulic Principles Governing River and Harbour Construction. By Curtis McD. Townsend. London: MacMillan and Co., Limited, St. Martin's-street, W.C. 2. Price 12s. net.

Nickel Ores. By W. G. Rumbold. Prepared under the direction of the Mineral Resources Committee of the Imperial Institute. London: John Murray, Albemarle-street, W. 1. Price 5s. net.

The Advancement of Science, 1923. Addresses delivered at the ninety-first annual meeting of the British Association for the Advancement of Science. London: John Murray, Albemarle-street, W. 1. Price 6s. net.

SIXTY YEARS AGO.

Sixty years ago transport by sea to those who entrusted their lives or their money to it was attended with difficulties and risks which we of a modern generation have largely forgotten. In our issue of October 9th, 1863, we summarised a return made by the Board of Trade to Parliament showing the wrecks and casualties that had occurred in 1862 on the coasts and in the seas of the British Isles. During that year 455 vessels were totally wrecked and 66 totally lost by collision. In addition 1306 vessels were seriously, or otherwise, damaged by collision or other cause. These disasters or mishaps entailed the loss of 690 lives. All told, there were, on the average, five marine accidents per day round our coasts. Of the vessels covered by the return, 341 were of less than 50 tons, and 441 between 50 and 100 tons. Averaged over the preceding eleven years, nearly 800 people lost their lives per year within sight of our shores. Those saved by the lifeboats and other means averaged 700 or so a year. Yet by many the situation was viewed with complacency. Even we ourselves wrote that with over a quarter of a million entrances to, and clearances from, our ports, involving the movement of some 1,600,000 people, "it becomes almost a matter of certainty that a large number of casualties should take place amongst them every year." If the dangers of seafaring were thus great, the risks attending the investment of money in steamship undertakings were, for the moment, at any rate, given equal claim to attention by the unfortunate experience of the shareholders in the company owning the Great Eastern. In a leading article we described that vessel as commercially almost a total failure, and, it was added, in this respect, the ship had fulfilled the conviction we had expressed regarding her before she left the Thames. The great vessel had a length of 692ft., and a tonnage of 20,000, and was driven by a combination of screw and paddle machinery. We urged that she should be purchased by the Government, that her paddle machinery should be removed, and that either as a single or twin-screw vessel she should be held in reserve as a troopship to carry an army at any time to any part of the world. How the "hapless and helpless" shareholders were, in the end, to be relieved, in part, of their loss, was accurately forecast in a paragraph printed in the same issue. Under the heading "The Atlantic Telegraph," we read that a renewed attempt to lay a telegraph cable across the Atlantic was expected to be made "next July." A scientific committee, consisting of "Captain Galton, Mr. William Fairbairn, Mr. Whitworth, Professor Wheatstone and Professor Thomson," had reported on the various plans for the construction of the cable submitted by different makers, and had recommended the acceptance of the offer sent in by Glass and Elliott—a firm of rope makers in the first instance, from which the Telegraph Construction and Maintenance Company of to-day takes its origin. Nothing, however, had been decided regarding the actual laying of the cable, but, it was remarked, "if the Great Eastern should be delivered from her present financial troubles and be again made fit for sea, it might be very usefully employed for carrying and laying the Atlantic telegraph."

High-pressure Steam Boilers.*

By D. S. JACOBUS.

Mr. Jacob Perkins was a pioneer in the use of high-pressure steam. In 1822, over one hundred years ago, he made an apparatus in which water was heated under a high pressure in a generator kept full of water by a force pump, and only a very small quantity of the highly heated water was allowed to escape at a time into a tube, where it flashed into steam and passed on to an engine. His generator of 1824 is described in the following way in a book entitled "History and Progress of the Steam Engine," by Elijah Galloway, published in London in 1830:—"The boilers, or steam generators as they are called, are in this case very thick cast iron bars, 5in. square, with circular holes perforated longitudinally through them of 1¼in. diameter, a transverse section of which is exhibited in the figure. They are arranged in three tiers, A, B, D, and are of sufficient length to lie across the furnace, and

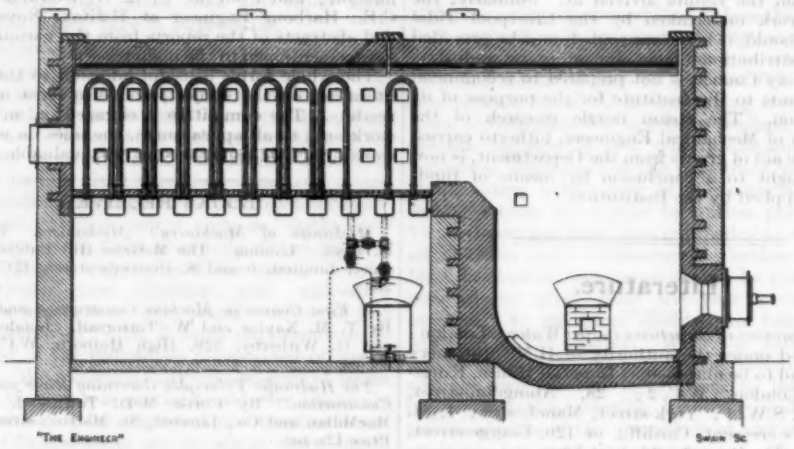

FIG. 1—BABCOCK AND WILCOX EXPERIMENTAL "SERIES" BOILER

to pass through the opposite walls, where their extremities are connected together, by a means we shall presently describe, so as to form one continuous vessel. By the operation of the forcing pump, water is continually injected into the two upper tiers of generators, so as to keep them always full, and under the pressure of the heavily loaded valve. The lowest tier of generators contain no water, but are kept at a temperature of about 1000 deg. Fah. At each stroke of the engine, a certain quantity of water, heated to about 700 deg. or 800 deg. Fah., is discharged into the valve box C, communicating with the lowest tier, wherein the water flashes into steam. The steam thus formed passes successively through every pipe in the lowermost range, which is exposed to the strongest action of the fire, before it enters, by a short tube, the safety chamber L, for the supply to the engine, to which it is conveyed by the pipe H. At G is a loaded valve to relieve the pressure, should the chamber become overcharged with steam." Heating the water to 700 deg. or 800 deg. Fah. would involve operating at the critical pressure of, say, 3000 lb. per square inch.

The late Mr. Frederick Sargent talked with me on a number of occasions in regard to the form of boilers that might be developed to meet the demand of increasing pressures. This led to the Babcock and Wilcox Company deciding that it would be advantageous to make experiments on a boiler built along entirely different lines from those it was constructing with the idea of determining the possibilities. This resulted in the design and construction of a boiler between seven and eight years ago in which there was a forced circulation and which had no steam and water drum. The boiler was purposely made of a form in which it was felt there might be certain difficulties in order to search out the principles involved in such boilers. The arrangement of the boiler in the form in which most of the tests were made is shown in Fig. 1. In the first tests the water was fed into the cross box most remote from the fire, passed in series through the loops from one cross box to the next, and finally left in a superheated state from the last cross box. But few tests were made on this form, and the boiler was changed by placing the separating tank, dotted in Fig. 1, between the economiser and boiler part and the set of loops nearest the fire which formed the superheater. The boiler was fed in the same way as in the first form, and the steam generated, together with some contained water, passed into the separator. The loops were constructed of 2in. tubes, and the straight portions of the loops were fitted with cores. The water was maintained at a given height in the separating tank by regulating the rate of supply of the feed water, and at the same time a small amount of water was continually bled from the separating tank and returned to the feed water. This insured the passage of a certain amount of water at all times through the economiser and boiler element. From the separating tank the steam was passed to the superheater located next to the fire. The name "Series Boiler" was applied to the apparatus.

It was first intended to place boiler surface ahead of the superheater so that the hot gases from the furnace could pass first over boiler surface, then over the superheater, and thence over the boiler and economiser surface. In order to simplify the apparatus, the boiler surface was not placed ahead of the superheating surface, and doors were provided in the setting for tempering the gases from the oil-fired furnace to a point where they would be at a low enough temperature to avoid burning the superheater. After the cores had been adjusted to the size finally used, it was found unnecessary to admit air to prevent the superheater from being burned out even though the oil furnace was at a high temperature. The superheater tubes became coated with black oxide on the outside, but they did not burn out nor was there any trouble through leakage throughout the tests, although the superheater might have failed eventually had the boiler been run for a longer time. The boiler was operated at a maximum capacity of about 425 per cent. of rating, based on the entire amount of heating surface of the economiser, boiler and superheater. The surface was not arranged in a way to give efficient results, the object of the tests being to determine the features of circulation and the practicability of operating a boiler of the sort.

In operating a series boiler, care must be taken in starting up to maintain a circulation of water or steam through the boiler. This would necessitate the installation of special arrangements in a power plant, especially if the heat imparted to the boiler in the starting up is returned to the system. Again, it is difficult to operate a boiler of the sort under fluctuating loads, and in any event the feed-water pumping system must have 100 per cent. reliability.

It was therefore decided to build a series boiler to be used in combination with a relatively small boiler, having a steam and water drum. The combined unit shown in Fig. 2 was therefore constructed.

This consisted of a boiler with 2in. tubes having a steam and water drum and a combined boiler and economiser with 1in. tubes, in which the heating surface was 3.7 times the heating surface of the boiler having the steam and water drum. The unit was a comparatively small one, having 187 square feet of tube surface of the boiler with the steam and water drum exposed to the hot gases, 51 square feet of superheater surface, and 685 square feet of boiler and economiser surface in the section made of 1in. tubes, or 923 square feet of heating surface in all. The boiler was fired with oil fuel with a mechanical atomising burner and operated at 600 lb. gauge pressure. A connection fitted with a valve was run from the steam and water drum to the lowermost part of the series boiler, and this connection was left open in starting up the boiler, so as to provide a local circulation. The unit was run at times at over 500 per cent. of rating, based on the total boiler and economiser surface, and all parts were found to operate in an entirely satisfactory way. The percentage of rating at which the boiler with 2in. tubes having the steam and water drum was operated in the high-capacity tests was about 1500 per cent.

We are building boilers for 1200 lb. working pressure with wrought steel economisers for power plant service of the general form shown in Fig. 3, which is illustrative only as certain features of the tube arrangement may be changed. In developing this boiler, we had before us the results secured for the use of 1in. tubes in a great number of our White-Forster marine boilers for destroyer service and the results of the experiments with the series boiler. A great number of different arrangements were laid out and considered, and the one finally adopted was that shown in Fig. 3, which approaches very closely to a standard Babcock and Wilcox boiler. In this boiler the steam generating tubes are 2in. in diameter, which is a convenient size for internal cleaning, whereas it is difficult, if not impossible, to properly clean tubes, say, 1in. diameter and smaller. The steam and water drum, which is 48in. internal diameter of forged seamless steel construction, provides a reserve water capacity, making it easy to operate the boiler under all sets of conditions, such as in starting up and under variable loads, and making it unnecessary to provide pumps having 100 per cent. reliability, such as would be necessary for a series boiler. The tubes are arranged so that they can be thoroughly cleaned on the outside from between the diagonal lanes. The feed water from the economiser passes directly into the boiler, which makes it necessary to build the economiser for a somewhat higher pressure than the boiler. The economiser is made up of 2in. seamless steel tubes expanded into forged steel boxes. The boxes are spaced apart to allow the removal and replacement of the economiser tubes from between the boxes with the tubes at an angle which allows the tubes to be removed and replaced with a relatively narrow aisle width. The ends of the horizontal circulating tubes of the boiler are bent so that they enter the drum in circumferential lines which are twice as far apart as the distance between the horizontal circulating tubes where they enter the headers. This greatly increases the efficiency of the ligaments between the tube holes. There are two circulating tubes running from the top of each uptake header to the steam and water drum. The boilers are built to meet the requirements of the A.S.M.E. boiler code. Certain features of the forged steel drum are not covered in the A.S.M.E. code, but the general character of the steel in the drum will conform closely to that specified in the A.S.M.E. code for boiler plate and the maximum allowable stress is taken at 11,000 lb. per square inch, thereby corresponding to the figure specified in the code.

The boilers built for 1200 lb. working pressure will be supplied with individual steam turbines. It is the idea to eventually generate all of the steam for a power plant with high-pressure units of the sort, and after passing the steam through several of the high-pressure steam turbines to pass the exhaust steam from these high-pressure steam turbines to a main steam turbine. The steam supplied to the high-pressure steam turbines is superheated to a total temperature of, say, 725 deg. Fah., by primary superheaters. The exhaust steam from each individual high-pressure steam turbine is returned to a secondary superheater placed within the high-pressure boiler setting at a pressure of, say, 300 lb. above the atmosphere, and is re-superheated to a temperature of, say, 725 deg. Fah., and supplied to the main steam turbine. The individual high-pressure steam turbines therefore serve to reduce the pressure of the steam from the initial pressure of 1200 lb. to that used at the main steam turbine. With an economical main steam turbine operated with the exhaust steam from the high-pressure steam turbines, the amount of power generated by the high-pressure steam turbines would be 20 to 25 per cent. of that generated by the main steam turbine. Should the main steam turbine be run at a lower pressure than 300 lb. and at a lower temperature than 725 deg. Fah., the gain through using the high pressure would be increased and might reach, say, 30 per cent. or more. There is a possibility, therefore, of re-vamping present power stations and considerably increasing their efficiency through using the high-pressure units with individual steam turbines

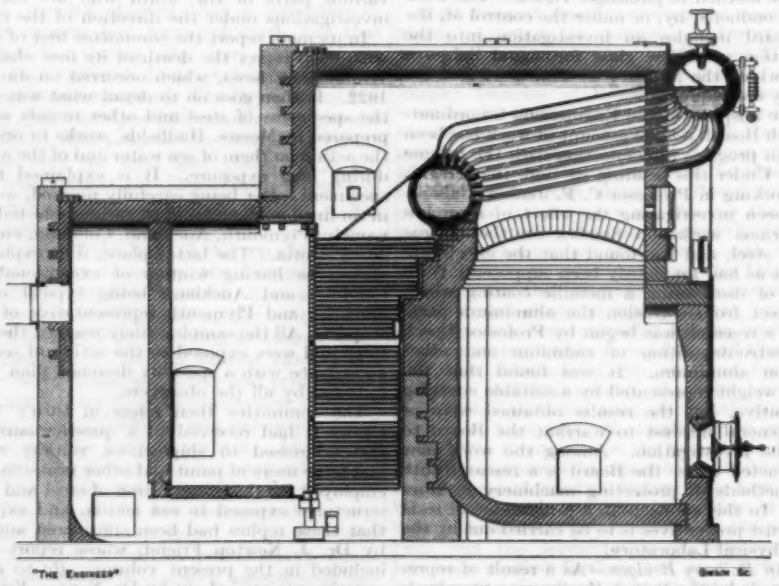

FIG. 2—"SERIES" BOILER IN COMBINATION WITH BOILER HAVING STEAM AND WATER DRUMS

and exhausting the steam into the present steam mains. In order to warrant the additional investment necessary for installing the high-pressure boilers in an old plant, it would be necessary to have a very steady load, or what is known as a "base load condition." The investment would not be warranted under present conditions for a widely fluctuating load.

In place of using individual high-pressure steam turbines for each boiler, the high-pressure steam from a number of boilers could be used for larger high-pressure turbines. Experience alone can demonstrate which system will be best, and no one can say what plan will be adopted in the future in the effort to secure higher and higher efficiencies. There will no doubt be difficulties that cannot be foreseen to be worked out, and those who are pioneers in installing high-pressure units of the sort should be commended for their willingness to spend the time and money that will be necessary in the development.

If it were possible to maintain absolutely tight surface

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condensers, it would be unnecessary to clean the interior of the boiler tubes, and the problem of designing high-pressure boilers for power plant service would be greatly simplified. Under present conditions, there is always a chance of leakage at the condensers, either at the tube ends or through the cracking or corrosion of the tubes, and this necessitates arranging the boiler so that it can be cleaned on the inside. Tight condensers and the use of a closed system would also overcome any trouble through corrosion due to oxygen in the feed water on the interior of the economisers and boilers. The fact remains, however, that leakage in condensers has not as yet been overcome, and the problem of both cleaning the interior of the tubes and of removing any excess oxygen from the feed water must be faced in all cases.

The effect of temperature on the lowering of the elastic limit of steel has been referred to by engineers as something that might give trouble in a high-pressure steam boiler. At a temperature of about 750 deg. Fah. the elastic limit may drop to half that obtained at ordinary room temperatures, and it is important that the effect of this falling off be understood. The temperature of the saturated steam corresponding to 1200 lb. pressure is somewhat less than 570 deg. Fah., and at this temperature the strength of the steel is higher than at ordinary room temperatures and the elastic limit is about the same or only slightly lower, so there need be no apprehension with respect to the boiler proper. The only part that is affected through being brought to a temperature that would cause any material difference in the strength or the elastic

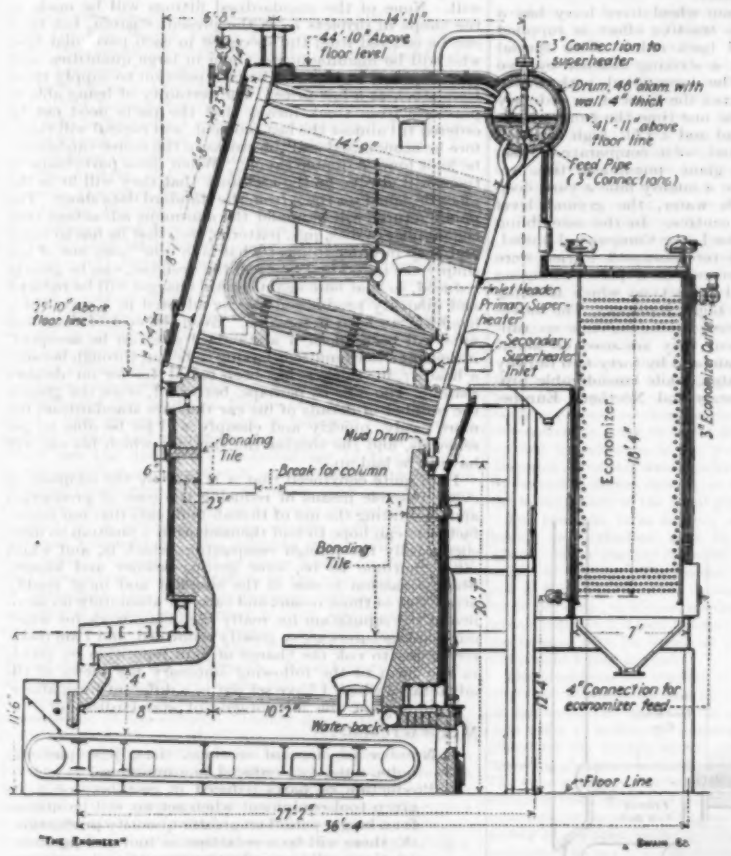


FIG. 3—BOILER DESIGNED FOR A WORKING PRESSURE OF 1200 lb.

limit of the steel is the superheater. Of all parts of a boiler the superheater is the safest as far as its liability to injure anyone or to cause property damage is concerned, as the worst that might happen in case the superheater became overheated would be to burn out or blow out some of the tubes, and this would not ordinarily result in any damage other than to the superheater itself.

The effect of a rising temperature is first to increase the tensile strength of steel from, say, 10 to 20 per cent., and afterwards to decrease it, and at 700 deg. Fah. the tensile strength is about the same as at ordinary room temperatures. At 750 deg. the tensile strength falls off, say, 10 per cent. below what it is at ordinary temperature, and the elastic limit is about one-half what it is at ordinary room temperatures. In a complicated structure used under pressure at 750 deg. Fah., the falling off in the elastic limit would result in a liability for leakage, and in such a structure it might be well to use a factor of more than 5 based on the tensile strength. In a structure like a superheater, however, there would seem to be no necessity of providing a factor of safety of more than 5 based on the tensile strength. We have become so accustomed to the use of relatively high factors of safety in boiler construction to those used in some other lines that we are apt to overdo matters to make sure we are on the safe side. When one considers the relatively low factors used in the design of large guns and for torpedo tubes carrying very high pressures, one feels a great deal safer when it comes to boiler design. Again, in the work we have done in designing and building oil stills and tanks for use at high pressures and at temperatures of 825 deg. Fah., we made a careful study of the falling off of strength and elastic limit and of the practice in still design that has been found to give safe results, and all this makes us more confident in feeling that the factors of safety we are using in boiler and superheater design are ample.

As superheated steam of higher and higher temperatures is being used in power plants, the time is approaching when it may be necessary to provide some automatic means for preventing the temperature exceeding a certain figure. It has been the general practice to run at a temperature which can be exceeded for a time without giving trouble. The Babcock and Wilcox Company made experiments over ten years ago to develop an apparatus for attemperating superheated steam and maintaining the temperature at a given figure, provided the initial temperature of the steam entering the attemperator was at a somewhat higher temperature than the steam discharged. It was found entirely practicable to hold the temperature within a range of, say, 5 deg. or 6 deg. Fah. between the highest and lowest points by spraying a regulated amount of water into the superheated steam. The apparatus consisted of a vessel containing water placed in the exit pipe conducting the superheated steam away from the attemperator. There was a definite pressure generated in the vessel for each particular temperature through boiling the contained water, and this pressure acted on a diaphragm and actuated an apparatus for admitting more or less water to the superheated steam. The temperature of superheated steam that could be handled in this way was limited to, say, 650 deg. Fah. For higher temperature than this it was proposed to use mercury in place of water in the vessel. Shortly after experimenting with the attemperating device, the idea was applied to an independently fired superheater as a superheat limiting device, where, on the temperature rising to a given point, doors were opened in the setting for admitting cold air. This arrangement proved to be entirely reliable through trials made every twenty-four hours, where the temperature was purposely raised to the point for which the apparatus was set. An interesting feature developed, as it was found possible to operate the independently fired superheaters much more closely through observing the pressure in the vessel containing the water than by reading a thermometer. The vessel consisted of a coil having a considerable surface in contact with the superheated steam in proportion to its volume, and an attached pressure gauge indicated changes in temperature much more effectively than a thermometer, as the change in pressure due to the boiling of the water was greater than the corresponding change in the temperature. For example, raising the temperature from 490 deg. to 500 deg. Fah. resulted in raising the pressure 62 lb. per square inch, so that there was a change indicated by the pressure gauge of about 6 lb. for each 1 deg. Fah. It was found that the superheater could be operated at such a constant exit temperature through observing the pressure gauge that a recording thermometer placed on the outlet gave practically constant readings.

An apparatus of the sort could be used either for attemperating the steam and holding it at a given temperature, or it could be used as a limiting device to reduce the superheat in an emergency without attempting to maintain the temperature of the steam at a given figure.

In the latest boilers for high-pressure and high-temperature superheated steam built by the Babcock and Wilcox Company, the superheater is placed above a series of tubes in a drop leg and below the main body of tubes of the boiler. A superheater properly arranged in this position in a properly designed boiler gives a more constant degree of superheat at different ratings than if placed in the ordinary position above the boiler tubes and permits a higher degree of superheat to be obtained with a given amount of superheating surface, and for the temperature of superheated steam now employed the superheat obtained with a superheater of the sort is near enough constant for use without an attemperating device.

There is but little gain in the economy in increasing the steam pressure to a higher point than 350 lb. per square inch without interstage heating of the steam; that is, the steam from one stage of the turbine must be withdrawn from the turbine, re-superheated and returned to the following stage of the steam turbine. Interstage heating necessarily involves additional complication and added expense, and the possible difficulties in operation due to the additional complication have an important bearing on the use of the higher steam pressures.

The Quarter's Shipbuilding.

Lloyd's Register Shipbuilding Returns for the quarter ended September 30th, which have just been issued, show that the tonnage under construction in Great Britain and Ireland—1,271,195 tons—was about 67,000 tons less than at the end of June, and that the decrease as compared with twelve months ago reached about 346,000 tons.

This decrease, however, does not, it is explained, sufficiently indicate the present conditions in the shipbuilding industry in this country, as the present total includes 242,000 tons on which work has been suspended for a long time, or is in abeyance owing to the unfortunate dispute now affecting the yards. Deducting this tonnage in order to enable a comparison to be made with figures for normal times, it is shown that the tonnage actually under construction at the end of September amounted to only 1,029,000 tons, which figure is the lowest recorded in the Society's returns for a period of nearly fourteen years. The average tonnage being built during the twelve months immediately preceding the war was 1,890,000 tons, *i.e.*, 861,000 tons more than the present total.

There was, naturally, a considerable decrease in the tonnage launched during the quarter, namely, 66,474 tons, as compared with 239,373 tons during the second quarter of the year. The work commenced was similarly affected. During the quarter ended June 30th, 77 vessels, representing 241,283 tons were started, whereas similar figures for the quarter under consideration were only 29 vessels of 111,860 tons.

The total merchant tonnage being built in other countries is given as being 1,106,502 tons, but that figure includes about 83,000 tons upon which work has been suspended, leaving about 1,024,000 tons actually under construction; the latter figure is 50,000 tons less than at the end of June, 1923. The figures for the leading countries abroad are:—Germany and Danzig, 345,985 tons; Italy, 145,423 tons; France, 142,660 tons; Holland, 104,491 tons, and United States, 99,383 tons. As regards the number and tonnage of vessels launched and of vessels commenced in the world during the quarter under review, it is stated that 227,549 tons were launched abroad and 100,372 tons were commenced; the latter total, however, does not include vessels commenced in Germany during the quarter, accurate information on that subject not being yet available. The total world tonnage—2,377,697 tons—includes 325,000 tons (of which only 83,000 tons are outside Great Britain and Ireland) on which work is suspended. The tonnage actually under construction is, thus, 2,052,000 tons, which total is 1,394,000 tons below the highest pre-war record reached on June 30th, 1913, viz., 3,446,558 tons.

The returns show that there are at the present time 28 steamers and motor vessels, each of over 1000 tons, with a total tonnage of 178,590 tons, under construction in the world for the carriage of oil in bulk. Of these tankers, 14 of 92,790 tons are under construction in Great Britain and Ireland. The tonnage of vessels now being built in the world which are to be fitted with internal combustion engines, amounts to 460,868 tons, equal to over 24½ per cent. of the steam tonnage under construction, thus showing the continued development which is taking place in the adoption of this system of propulsion. There are at the present time under construction in the world 28 vessels of between 10,000 and 20,000 tons each and 10 of 20,000 tons and upwards; these figures include 25 vessels being built in Great Britain and Ireland, 7 of which are of the larger size.

Of the vessels under construction in the world—which total excludes vessels the construction of which has not actually been commenced and also vessels of less than 100 tons—341 of 1,268,571 tons are under the inspection of the Society's surveyors, with a view to classification in Lloyd's Register Book.

Ceramic Society.

The autumn meeting of the Refractory Materials Section of the Ceramic Society was held in the Grosvenor Museum, Chester, on October 4th and 5th, under the presidency of Mr. J. Holland.

In a paper, of which the President and Mr. W. J. Gardner were joint authors, the improvements which had been effected during a recent period in the drying of refractories were discussed. It was pointed out that the usual drying floor and enclosed stove methods had very objectionable features, and recent legislation had impressed upon manufacturers the desirability of evolving a method of drying silica bricks which would reduce to a minimum the dusty conditions of ordinary work. The plant with which experiments were made was a stove heated by gases and the products of combustion radiating through the floors and side walls. The materials were transported during the drying process through the stove on wrought iron plates running over a tramway worked by means of a worm shaft connected with the main drive of the works mill. The drying chamber was 60ft. long and 3ft. wide, and formed the hot zone. A flue extended from end to end of the chamber and was connected to a suitable furnace, or was heated by hot gases from the kilns or other convenient source. The floor and side walls of the drying chamber were composed of slabs of refractory materials. At the rear end of the chamber was a cold zone 10ft. long, which was cut off from the drying chamber by a baffle. Along each side of the main flue, under the drying chamber, passages for secondary air supply were provided, this air being admitted to the drying chamber after preheating. Cold air was mixed with the secondary air in the cooling section of the stove, and assisted in taking off the steam and drying the goods. It had been found that if an even temperature was maintained and means taken to prevent the heated goods being suddenly subjected to cold air, the bricks were delivered at the drawing end quite strong, dry and cool, and ready for selling. The stove was fitted with pyrometers and temperature and draught recording instruments. A stove of two chambers, now in operation at the works of the Meltham Silica Brick Company, Limited, was capable of drying 8000 bricks per shift of nine hours at a temperature of about 100 deg. Cent. at the centre of the stove above the bricks. In addition the requirements of the Home Office, particularly with reference to silica dust, were more easily and effectively observed.

The Proctor dryer was described by Mr. A. H. Middleton. He said that in this dryer the wet goods were thoroughly heated to their core in an atmosphere of high humidity before any surface drying could take place. This was the fundamental difference in principle between this type of dryer and drying on an ordinary hot floor. This type of machine had been installed at Consett, and in the form of a three-track tunnel truck dryer had a total capacity of 14,976 bricks.

During the past year the Consett installation had suc-

cessfully dried 1½ millions of ordinary bricks, and nearly 4000 tons of difficult coke oven and gas retort segments. The machine was divided into three zones by the relative positions of the dry air inlet, the wet air inlet and the disposition of fans, baffle plates and heating coils. Throughout the whole length of the machine—50ft.—a strong current of air was maintained. Except where the heat necessary for drying could be obtained from exhaust steam or other source, which would not otherwise be utilised, the Proctor type of dryer enabled large savings to be made in the fuel bill.

Mr. R. Maclaurin, in a contribution describing methods of producing gas for industrial operations, said that gas made from coal was too costly from the standpoint of the ceramic industry. Dealing with the carbonising plant with which his name is associated, the author said it was a producer of coke as well as gas. Gas could be made in it by utilising duff as fuel at a cost of about ¾d. per therm. He claimed that the gas from a Maclaurin producer working for coke met the requirements of the ceramic industry.

Dealing with the effect of salty coal upon refractory materials, Mr. L. M. Wilson described a series of experiments on high-grade silica bricks and fire-clay bricks. The work, which was started at Eskmeals last year, has been completed in the Refractories Department of Applied Science at Sheffield. The author said that the research indicated that there was a critical temperature at 900 deg. Cent. where the chemical properties of burned fire-clay appeared to undergo a change quite apart from the critical temperatures where the physical properties of either raw or fixed materials were known to alter. The experimental evidence demonstrated the superiority of high-grade silica over fire-clay for the lining of coke ovens as regarded resistance to salty coal. At temperatures between 700 deg. and 1200 deg. Cent., ammonium chloride removed iron and alumina from fire-clay, and iron, alumina and calcium from silica bricks.

The Motorailer.

On Monday last we witnessed at Slough some interesting demonstration trials of a new device for enabling ordinary motor vehicles to travel on rails and, in a similar way, vehicles primarily built for railway service to travel on roadways. The device we refer to is termed the "Motorailer," and is manufactured under the patents of General Sir H. C. Holden, by the Motorailer Transport Company, Limited, of Avenue House, 21, Northumberland-avenue, London, W.C. 2. At the present time two specific applications of the system have been made, and these are illustrated by the engraving accompanying this article.

The first application of the motorailer, which we examined and saw tested, was that which has been made on a heavy lorry of the four wheel drive type. This motor vehicle was largely used for heavy haulage work during the war, and is well fitted for rail service on account of the drive being transmitted to both front and back wheels and its four equal speeds ahead and reverse. The wheel construction is shown in Fig. 1. A high carbon cast steel track wheel is employed having six elliptical arms and a rim specially shaped to conform to standard gauge railway track, as shown in the lower left-hand view reproduced in Fig. 1. In order to allow solid rubber tires to be fitted to such wheels with a minimum of time for attachment and detachment, use is made of a 30in. diameter tapered loose rim, which slips over the main rim and forms an intermediate member between it and the steel ring at the base of the rubber tire. This loose ring, which, after being machined, is cut at a 60 deg. angle after the manner of a piston ring, is held in position by six ⅜in. hardened steel bolts with a sector-shaped head—see Fig. 1—which engages in a milled slot formed in the loose rim. Fine threads are used, and as far as present tests show, there is no need for a special locking device. When removing the loose rim starting screws are placed on tapped holes in the bolt heads, and after the main nuts have been removed the rim is forced off with a few turns of the starting screws. For prolonged road service the starting screws are removed. In the tests which we saw on Monday, the lorry equipped for road use was aligned on the railway track at a level crossing, the wheels jacked up and the four loose rims and solid rubber tires removed within the space of about 8½ min. After demonstrating the running capabilities of the vehicle on rail, the rubber tires were again put on, the time taken for replacement being about half an hour.

Another application of the motorailer is its use on a standard 1-ton Ford truck, and the method of attaching the pressed steel rail rim to the Ford wheel rim is shown to the right in Fig. 2. In this case cap nuts with a distance piece in the form of a bush are used along with the standard Ford bolts. This method of conversion was demonstrated and the ordinary tires were removed from the truck and the rail rims put on in slightly over 13 min. The truck was then run on the railway track with satisfactory results.

A further appliance which is being made by the company is a wheel extractor or "Motorlifter." This consists of a wooden cleat shaped to fit the rubber tire, which is secured to the rim of the wheel by a chain passing round the outside of the cleat and encircling the rim between the spokes. When a vehicle becomes bogged, a plank or tree trunk is placed transversely across the wheel face with the cleat or "motorlifter" resting upon it, so that when the engine is clutched in the axle is lifted clear. Usually three "motorlifters" are attached to the wheel. The wheel extractor we have described was used during the war, and we understand that under drastic conditions of mud and snow, the largest Army lorries, though embedded up to the hub, were able to extricate themselves when fitted with this device. The "motorlifter" can be made both for lorries and touring cars, and it is probable that it will find wide use in countries such as Australia and Africa, where metalled roads are comparatively few and cars are liable to be held up by mud in the rainy season and by sand in dry weather.

In this respect also the four-wheel-drive lorry has a distinct advantage, since the tractive effort is supplied through both the front and back axles. This special feature was demonstrated in a striking manner by two different types of lorry. The lorry fitted with motorailers and solid tires negotiated the lines of an ordinary railway track, and although at one time the front wheels were confined between one rail and a 12in. high concrete wall, this latter was mounted with comparative ease. A similar lorry fitted with giant pneumatic tires repeatedly extricated itself from a muddy hole a yard deep which was partly filled with water, the ground level being well above the wheel centres. In the assembling shops of the Four Wheel Drive Lorry Company, Limited, at Slough, several new and reconditioned lorries were seen, and special interest centred in a petrol shunting locomotive of the four-wheel-drive type which is being built for the Derwent Valley Light Railway. The movement in connection with petrol motor services on railways is extending. At present they are used on about six branch lines in Great Britain and by forty-two railway companies in the United States, while considerable progress has been made in France and Northern Europe,

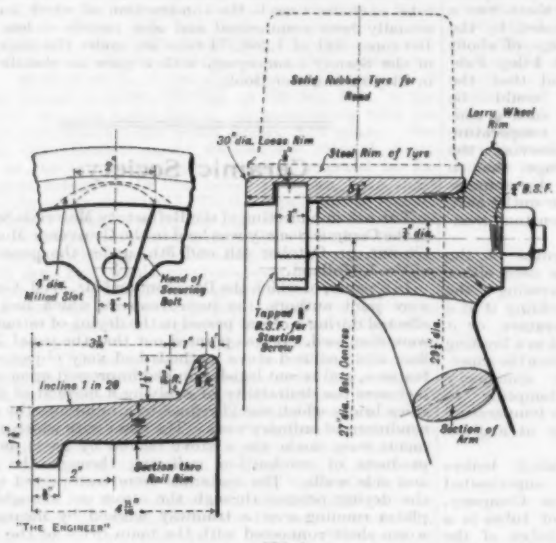


FIG. 1

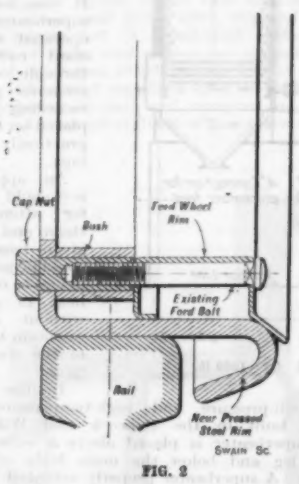


FIG. 2

and also in Australia, South Africa and South America. In this connection the following particulars of four-wheel-drive cars used on rail in America, and furnished by the makers of these lorries, are of interest. They refer to rail omnibuses, having a carrying capacity for forty persons and making daily runs of from 120 to 150 miles.

Railway company.	Petrol consumption, miles per gal.	Operation costs and repairs per mile, d.
New Orleans and Lower Coast Railway, U.S.A.	8½	8½
Manhattan City and Interurban Railroad	—	8½
Northern Pacific Railway, U.S.A.	9	7½

Returns of petrol locomotive costs on these and other railways appear to show on short lines a saving over steam locomotives. In New South Wales, we learn, the Government railways have successfully demonstrated the adaptability of ordinary road chassis to rail work by converting a motor lorry which had been running on the streets of Sydney into a motor train with trailer, which has been in successful operation for over two years. The car has seating accommodation for thirty-three, and the trailer carries goods and parcels. The gross earnings per train-mile during twelve months are stated to be 50.31d., and the working expenses 14.85d., excluding share of maintenance of track, which is also used for steam trains.

Another use for such vehicles may be found on tramway systems, and in China the petrol lorry has been so used with good results. The devices we have described should certainly help to enlarge the areas served by railways, and this particularly in colonial countries where, at present, there is need for better means of communication between roads and railways.

Standardisation of Motor Car Parts.*

It is probable that the fundamental reason why more progress has not been made with the standardisation of automobile parts is the failure on the part of many firms engaged in manufacture to realise both its importance and its scope. First of all, it has to be realised that standardisation is only intended to apply to the detail fittings which are common to all cars, so that originality and individuality shall be in no way hampered or interfered with; it is, for instance, never suggested that a type of radiator or a bonnet shape—two such conspicuous examples of individuality—shall be standardised. When once this idea has been fully grasped one impediment will have been removed, and it is only then that the advantages of standardisation will receive their due consideration. The advantages begin to show themselves in the very earliest stages of the design of a car—the drawing-office. When standardisation has been carried far enough, the draughtsman will no longer have to spend hours in laying out some carefully calculated flange diameter and pitch circle; he will not have to draw out some dumb-iron, step bracket, lamp bracket, or radiator drain cock to suit his individual fancy. For all such parts he will simply have to consult his data sheet and mark up the drawing "Standard Step Bracket No. 1" and indicate the position of the bolt holes from the data sheet and his work on that part is done, and so on with many other such parts. In the shops the saving is greater still. None of the standardised fittings will be made in the shops in driblets as is the present custom, but they can be ordered from the specialist in each particular line, who will be manufacturing them in large quantities with special plant, and so will be in a position to supply them from stock at a low price. The certainty of being able to purchase from stock means that the parts need not be ordered till almost the last moment, and capital will therefore be economised and the stocks in the stores can always be kept low—a double saving. When these parts come in there will always be the certainty that they will fit in the place designed for them from the standard data sheet. The manufacturer will be under the enormous advantage that the number of dies, jigs, patterns, &c., that he has to make and keep in order to meet what is in nine cases out of ten simply the individual fancy of the designer, can be greatly reduced, so that here again capital charges will be reduced and quantity production can be adopted in a way which has hitherto been impossible. Even the cost of bolts and nuts will be reduced if a standard size can be accepted, instead of a few hundreds having to be put through because a head $^1/_{32}$in. thicker has been called for for no definite reason. The user is, perhaps, better off, since the greater the number of details of his car that are standardised the more easily, quickly and cheaply will he be able to get renewals, and the shorter the time for which his car will have to be laid up.

I am quite convinced that it is only by the adoption of every possible means of reducing the cost of production and facilitating the use of British-built cars that our manufacturers can hope to find themselves in a position to meet successfully the foreign competition which is, and which must continue to be, ever getting keener and keener. Standardisation is one of the simplest and most readily attainable of those means and calls for absolutely no sacrifice of the reputation for really high-class work for which our manufacturers are so greatly renowned, and I am therefore going to risk the charge of vain repetition by giving in the form of the following summary my views of the advantages which I have set out in a different form above.

Summary of the advantages of standardisation:—

Manufacturing:

1. Number of sizes of sections, dies, jigs, patterns, bolts, nuts, &c., reduced to a minimum.
2. Production of parts reduced in cost because (*a*) a given tool equipment when set up will be utilised for a longer period on greater quantity production; (*b*) there will be a reduction in tool and jig costs; (*c*) there will be a reduction in overheads per piece.
3. Increased saving by producing in quantities, the producer having more confidence in a standard line.

Selling:

1. Sales would be easier and export business more readily effected.

Operating:

1. Repairs more easily effected, and replacements more quickly obtained, so that in case of breakdown a vehicle is out of service for a shorter period.
2. Varieties and quantities of spares considerably reduced.

Now I would ask with the utmost urgency and with all the emphasis that I can command that every manufacturer should make a careful and thorough study of this question of the very real advantages which are to be obtained from standardisation in general. I feel convinced that they can only come to one conclusion, and when they have done so there will be no difficulty in enlisting their help, not only in preparing standards, but in adopting them when they have been prepared. All the work and energy expended in the preparation of a standard is practically wasted if only a few firms adopt the standard; it must be taken up by all, and only so can the full benefits be reaped.

The first step is for every firm to express its approval of the principle and then to nominate one or more members of its technical staff, whose specific duty it shall be to deal with all questions of standardisation, to suggest points for standardisation, to attend committee meetings, to criticise suggested standards, and finally, when a standard is approved, to see that everyone who is in any way concerned is made acquainted with that standard and that it is henceforward adopted, and then to watch the results with a view to putting forward revisions from time to time if thought desirable. Some such thorough-going step, together with the most complete and harmonious co-operation of all whose interests are even indirectly involved, is absolutely essential before standardisation can make real headway.

The Standards Department of the Society of Motor

* Institution of Automobile Engineers. From the presidential address by Mr. H. G. Burford, October 10th.

Manufacturers and Traders has now been put upon a proper footing and is ready to receive from all firms the names of the members of their technical staffs, who, while not already a member of a technical sub-committee on standardisation, may be appointed in accordance with the suggestion outlined above. The firms themselves will only be approached for information when it is thought that they are in a position to offer useful data, and it is most earnestly to be desired that such assistance, when asked for shall be immediately forthcoming, and I say confidently that the result will be to the advantage of individual firms and the industry in general.

I repeat that the results of standardisation and the simplification of parts are a profit-making policy, because they mean elimination of waste, and it can only be through what we can save that individuals or associations, industry, or commercial enterprise, and so the nation, can reach prosperity, since multiplicity of sizes and variety of parts must be paid for by the ultimate user. We can learn many lessons from our American friends in this direction, and whilst the older methods of manufacturing articles to suit the individual taste will still continue, the world's business will be best met by a close study of the points which I have endeavoured to make clear in the foregoing paragraphs.

The World Power Conference.

At the British Empire Exhibition, to be held at Wembley next year, the first World Power Conference will take place, under the presidency of the Right Hon. The Earl of Derby, K.G., between June 30th and July 12th. The conference has been promoted by the Council of the British Electrical and Allied Manufacturers' Association (Inc.), in co-operation with technical and scientific institutions and industrial organisations in Great Britain and other countries. The participating countries to date are the Australian Commonwealth, Austria, Belgium, Dominion of Canada, Czechoslovakia, Denmark, France, Great Britain, Greece, Holland, the Indian Empire, Italy, Norway, Roumania, Sweden, Switzerland, and the United States. The conference is to be divided into five divisions, which are classified as follows:—(1) Power resources, (2) power production, (3) power distribution, (4) power utilisation, (5) general.

Each national review of power resources will be treated in one or more papers and either by a single author or several in collaboration. Division 2 is to be subdivided into five sections, under each of which a general paper may be presented giving a review of current practice, with particular emphasis on the outstanding features of such practice and the probable future and trend of development. The general paper may be followed by papers on specific topics and preferably emphasising those features which are the distinctive contributions of the country. Power distribution (Division 3) may be dealt with by each National Committee in a general paper, with special papers to follow, if desired. Division 4, power utilisation, will be covered by a series of papers, at the decision of each National Committee. The subjects which will be dealt with under Division 5 will be those which do not readily lend themselves to classification in the previous divisions. In arranging the final programme certain papers on economics, finance and research may be placed in the earlier part of the programme, but such subjects as education, health, and publicity will be dealt with at special sessions of the conference. No arbitrary limit is to be placed on the length of papers, but authors are requested to limit them as far as is compatible with the adequate presentation of the subject. Purely descriptive matter is to be avoided, except when new developments are being recorded, and it is recommended that the papers should be directed to the defects and limitations of existing practice and the directions in which new advances are to be expected. It is proposed that an International Executive Committee shall be formed immediately prior to the conference, and on this Committee each participating National Committee will be represented, and the Committee will meet periodically at convenient times throughout the conference in order that the proceedings may be conducted in a mutually satisfactory manner. It is also proposed that the Committee shall be responsible for the reception, preliminary consideration, and ultimate promulgation of any resolutions passed at the conference.

Some of the papers that have been arranged to date are as follows:—"The Coal Resources of the World," by Sir Richard Redmayne; "National Review of Water Power in Great Britain and Ireland," by Professor A. H. Gibson; "Problems relating to Run-off Storage and the Allocation of Catchment Areas in Great Britain and Ireland," by W. J. E. Binnie; "Points Affecting Economy in General Lay-out and Design," by C. M. Norrie and W. H. Munro (Water Power Production Section); "The Scope of Development to Meet Progressive Demands," by E. C. Bergstrom, also to be read before the Water Power Production Section; "Steam Generation," by the Hon. Sir Charles Parsons; "Internal Combustion Engines," by James Richardson; "The Transmission and Distribution of Electrical Energy," by C. H. Merz; "Large Generators," by A. B. Field; "High-voltage Direct-current Generation and Distribution of Electrical Energy," by J. S. Highfield; "Mechanical and Hydraulic Variable Transmission of Power," by Dr. H. S. Hele-Shaw; "The Application of Electrical Energy," by Sir Alexander Kennedy; "Application of Power to Rail Transport," by Roger T. Smith and C. B. Collett; "Application of Power to Road Transport," by Colonel R. E. Crompton; "Illumination," by G. W. Sully; "The Financial Aspect of Hydro-electric Development," by George Balfour; "International Standardisation," by C. Le Maistre; "The Education of the Apprentice," by Professor A. P. Lawrie and Professor F. G. Baily; "The Education and Training of the Engineer of the Future," by A. P. M. Fleming; "The Importance of Greater Public Interest in Mechanical Processes," by T. C. Elder; "Co-operative Publicity in the Public Supply of Electricity," by J. W. Beauchamp; "The Study of the Human Element in Production," by D. R. Wilson. Sir Robert Hadfield and Dr. C. S. Myers are also to read papers. A considerable number of papers are now under consideration.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BOOSTER LOCOMOTIVES: UTILISATION OF THE MAIN ENGINE'S EXHAUST STEAM.

Sir,—Those interested in electrification rightly question the ability of booster engines to improve the conditions of present steam locomotives competitively with electrical traction. They certainly do provide an increment of cylinder power where the boiler power is not already exceeded by the cylinder power; as occurs in recent practice with "limited" maximum cut-offs, and of which a striking example was provided in the first four-cylinder simple locomotives built for the London and North-Western Railway, and afterwards converted to compound to reduce the steam rate per hour and thus to utilise the boilers.

Where the boilers have originally been under-cylindered, the "booster" provides a means of rectifying an error of design, equivalent to providing an additional main engine cylinder. Whichever form the additional cylinder capacity takes, the steam must be provided by the boiler, and, for 40 per cent. increased tractive power, an additional 40 per cent. steam per hour is required; for 50 per cent. increased tractive power, an extra 50 per cent. steam per hour is required.

A form of booster so far untried is that where one extra main cylinder is provided, having the same dimensions as the other two already existing—no reference is here intended to the George Stephenson three-cylinder patent—which may be cut out whenever required by the driver by shutting off its steam and opening the drifting valves. This means no idle cylinder at high speeds; but it is not more wasteful of steam and of mechanical power to run one cylinder with drifters open while the other two are working at the most economical cut-off known in locomotive operation—30 to 35 per cent. cut-off—than to run four cylinders at 17 per cent. cut-off to obtain the same tractive effort as is obtained at 30 to 35 per cent. cut-off. On the contrary, all tests, as made at Altoona and as realised throughout the Continent, in every-day working, show that cut-offs of less than 30 per cent. are wasteful, increasing in waste as the cut-off is further decreased.

Multiple cylinders run at short cut-offs and low mean effective pressures are uneconomical in steam, and the power output from a large capital investment is also low—as low, certainly, as with one extra cylinder to be only used occasionally for boosting, just as the geared booster also represents increased capital outlay per ton-mile, in operation for only a fractional part of the annual mileage.

In all boosters, either driving on the main engine axles or else geared to bogie or trailing wheels of engine or tender, the boiler has to pay for all increases of power; but quite unnecessarily so, since one-third of the total steam production of all locomotives is going to waste at all speeds, as may be at once verified by reference to the point of release on the indicator diagrams; and this waste, unless it is desired, may be taken up by booster cylinders driving on to small pairs of wheels through the intermediary of the usual gearing.

For example, it is desired, say, to "boost" a locomotive having two cylinders, 20in. by 26in., with six-coupled 80in. wheels, and a tractive effort of 16 tons, with a total adhesion weight of 60 tons. The booster is to drive, through gearing, a pair of 40in. wheels and to increase the maximum tractive effort by 50 per cent., or 8 tons, making 16 + 8 = 24 tons. The main wheels indicate 5.3 tons tractive effort per pair of wheels, while the booster with its wheels of smaller rail contact surface has to indicate 8 tons per pair.

The conditions for slipping of the booster in applications to single pair of wheels are thus pronounced, and might be mitigated by employing the wheels of the tender, in larger number.

In order to utilise the exhaust steam, the booster cylinders, placed on the tender, should have dimensions 22in. by 26in., operating at from one-third to one-fourth of the boiler pressure. The 40in. wheels run at twice the speed of the main wheels on any given train speed, and the displacement volume of the booster cylinders per hour is 2.43 times that of the main cylinders in adding 50 per cent. to the tractive effort and horse-power of the locomotive on any given steam consumption by the main engine. At the dynamometer the autographic record shows about 53 per cent. increased draw-bar power per each ton of coal consumed per hour on average while the booster is operating; but, as the small-wheeled booster cannot be kept running at express speeds, it necessarily has to be cut out at over 320 revolutions per minute.

If boosters must be employed with small wheels, there is at least no need to use boiler steam for them. Incidentally, while the booster is working there is the advantage of cutting down the stresses on parts of main engine, and so reducing the cost of upkeep of the main engine, covering also that of the auxiliary motor. For example, the exhaust steam booster has the effect of raising the back pressures against the main engine pistons by 25 per cent. higher than those which obtain with the booster when cut out. In consequence, the maximum net initial tonnages or stresses on cranks, pins, bearings at dead centres, when the turning effort is nil, are reduced by about 25 per cent.; and statistics—unpublished—show that the annual saving in money on repairs is also reduced by 20 to 30 per cent.

This is a form of improved steam haulage which is now actually levelling electrical operation very closely, while increasing the sweetness of the train running and in reducing the liability to breakdown through the reduction of the usual heavy initial stresses thrown on parts of the motion at every stroke end.

October 10th. Charles R. King.

THE EMIGRATION OF WORKMEN.

Sir,—I thoroughly endorse the conclusions of your correspondent, "Clyde Engineer." The decadence of our commerce, and the increase of unemployment is chiefly due to trade unionism, with its constant demands, and its ca' canny or go-easy policy.

For many years a system of trade unionism has been thoroughly organised in the services of the State and municipalities, and our elected bodies are the tools of an organised and unscrupulous Socialist propaganda. With public servants strongly combined in various trade unions, they are powerful and numerous enough to elect their employers, and fix their own rate of wages and conditions of employment. Hence the reason why the lavatory attendants, dustman, and park-keepers are paid £1 a week more in wages than the skilled engineer.

Twelve months ago people were under the impression that most of the working men of Great Britain belonged to one or the other of the trade societies. Now they know that organised labour comprises merely a minority, and, further, that many millions of the men who are said to belong to the trade unions are only nominally attached to them through compulsion or in order to obtain work. Over four million workers have left the unions because they have been badly led, and nearly all the British trade unions are insolvent. The organised workers comprise barely 33 per cent. of the total wage-earners of the country. If the other 67 per cent. can be made to see that it is they who pay at every turn for these conditions; that their opportunities are cut off on one side and their living expenses raised on the other by organised labour, which uses anything from a "peaceful picket" to direct action and a threat of starving the community to enforce its will, how long will they supply the passive, if not the active, support which has enabled these conditions to be brought about? The employer has his rights and will defend them. But the non-union men throughout the country, what of them? Their rights are just as precious, and indeed more so, because the employers and manufacturers can look out for themselves. It is not one class against another in industrial warfare; it is all the other classes against one, and that one the free and independent worker.

There is a political and industrial refuge for conscientious law-abiding non-union wage-earners in the National Free Labour Association, with thirty years' successful work and prestige behind it. Its very existence refutes the suggestion that trade unions are entitled to speak for all wage-earners. The assumption is altogether contrary to the facts.

We blame employers of labour, the very people the independent workmen should look to for support, for surrendering their rights as British citizens, by entering into agreements with trade union leaders to employ organised labour only, thus compelling free labour to fight at a disadvantage.

The free and independent workers, if they choose to combine, could sweep away the despotism they loathe and the whole mass of rules and restrictions and legal disabilities which keep them in bondage. Five-sixths of those who earn their bread with their hands claim the liberty to sell their labour and use their time as they please, instead of being forced to join a trade union or starve. They are not Bolshevics or Socialists, and their inclinations are all for their self-respecting individualism which has been the basis of our industrial greatness. If the free majority want to retain such freedom as is still left them, they must imitate the active minority. They must make their power felt in the only way it will tell—in the ballot boxes. The country is growing heartily sick of the monopolist trade unions, the general public are weary of the perpetual unrest, the unceasing civil war, by which our industries are harried.

Let all lovers of industrial freedom, law and order get together, and the claim of the trade unions to dictate industrial conditions will seem as ridiculous as it is in any case intolerable and unjust.

William Collison, General Secretary,
The National Free Labour Association.
5, Farringdon-avenue, E.C. 4, October 10th.

OIL ENGINE NOMENCLATURE.

Sir,—The issue of The Engineer of June 1st, 1923, contains my letter to the Editor on the above-named subject. Upon reflection, instead of classifying heavy oil engines with slang terms "bulb" and the like, as hitherto used by British and other manufacturers to denote their own make of engine—purposely to avoid the true inventor's name, "Akroyd"—I suggest that the following classification be adopted by manufacturers to denote all British-made heavy oil engines, *i.e.*, Class No. 1, "Akroyd cycle" automatic ignition; Class No. 2, preheated "Akroyd cycle" automatic ignition. Of course, each manufacturer would describe the special patented device used to "spray" or "atomise" the liquid fuel for combustion in the respective "Akroyd cycle" class engine.

Further, each manufacturer of Class No. 2 engine would describe the method employed to heat the combustion chamber or its equivalent, *i.e.*, with lamp or steam or electric device.

Examples for Class 2 Engines.—Lamp: The Hornsby. Steam: The Doxford. Electric: The Beardmore.

The above-mentioned classification is clear and descriptive for academic, workshop and all general purposes. The word Diesel no longer describes the oil engine to which it is applied, and it is evident from trade advertisements that British manufacturers have discarded the half-German word to describe their own British-made oil engines.

Why not "play the game," and recognise the true inventor, "Akroyd," of the two heavy oil engine cycles declared to be British inventions in the Oil Engine Nomenclature Committee's report sent out from the Institution of Mechanical Engineers, London, in January, 1923? British submarines and the like during the war were fitted with heavy oil engines working on my Akroyd automatic ignition engine cycle, yet those engines are chronicled in war history as "Diesel" engines.

"Akroyd Cycle" Heavy Oil Engines for Aviation.—Unless publicity is given to that type of "Akroyd cycle" safety automatic, or, as it is now being termed, "compression ignition oil engine," that type also will go to the credit of Diesel and the German nation.

Herbert Akroyd Stuart.
Claremont, Western Australia, September 6th.

Obituary.

CHARLES FREDERICK DIXON.

We are informed of the death on September 25th of Mr. Charles Frederick Dixon, chairman and managing director of the Cleveland Bridge and Engineering Company, Limited, Darlington. Mr. Dixon was born in 1859 and was educated at Marlborough. In 1882 he joined the company, and three years later bought it, converting it in 1893 into a limited liability company. Under his direction it undertook many important contracts for bridges and other structures, amongst which the Victoria Falls Bridge and the King Edward Bridge, Newcastle, are the best known.

A large deposit of radium is reported to have been found in Turkestan, according to an announcement from Petrograd, the discovery having been made by members of the Russian Radium Institute.

The Oxytome Metal Cutting Machine.

For a considerable time Alfred Herbert, Limited, of Coventry, has been experimenting with the object of producing an oxygen blow-pipe machine that would give a clean square-edged cut and would generally fill all possible requirements in a simple and easily-operated manner. One of the main objects in view has been to deal not only with small pieces but with work of the largest size, such as, for example, locomotive frames, boiler end plates and constructional members. The outcome of the firm's investigations in this direction is the machine known as the "Oxytome," which we illustrate herewith.

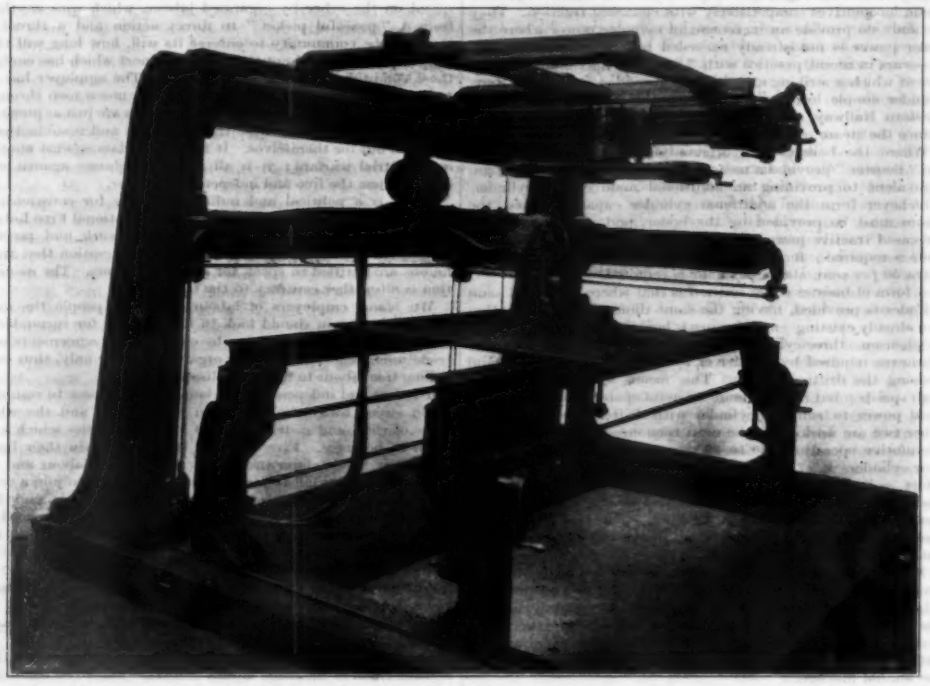


FIG. 1—OXYTOME ARRANGED FOR STRAIGHT OR CIRCULAR CUTS

The machine consists of the following main parts:—(1) Uprights carrying a longitudinal gantry which can be made any length in units of 10ft. each; (2) a lower arm which moves on ball-bearing rollers along the gantry and carries the saddle in which is fixed the blow-pipe; (3) an upper arm also mounted on ball-bearing rollers which carries the power operating and feeding mechanism for governing the movement of the blow-pipe; (4) a template or former holder used when cutting out irregular shapes, and (5) a work table with elevating device.

One of the main essentials for making a clean square-edged cut is a regular and uniform motion to the blow-pipe. This requirement cannot be obtained by hand control no matter how skilful the operator may be. It is ensured on this machine by the variable-feed control mechanism, which will guide or tow the blow-pipe at any desired rate of feed. That feed may be in a straight line in any direction at any angle, or in a circular path of any diameter up to 3ft. 9in., or in any irregular-shaped path following a former.

The blow-pipe has three supply lines, one for acetylene or coal gas, one for the oxygen for heating, and the third for the oxygen for cutting. The first two lines are opened in their proper order and the gas lighted by a single movement of one handle, the reverse movement of which cuts off the supply. Regulating cocks on all three lines are provided to ensure the best cutting condition. The actual lighting of the jet is effected by a pyrophoric apparatus. The jet can be quickly raised from the work when required, and is provided with a fine micrometer adjustment to regulate its height above the work. The whole blow-pipe is held in a roller-bearing saddle, which has a very free and sensitive movement along the arm. As the arm is also mounted on roller bearings it has an equally sensitive movement along the gantry.

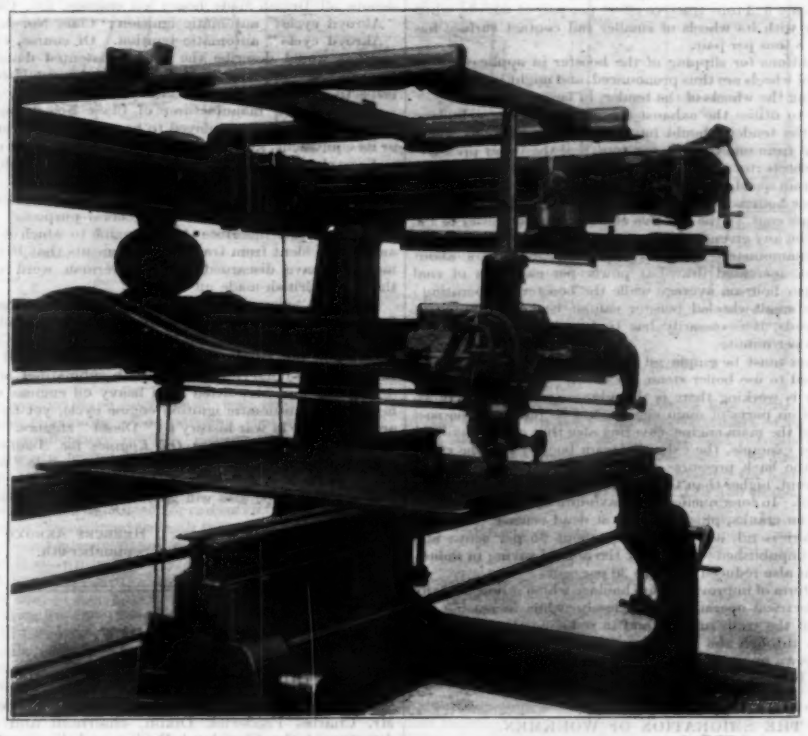


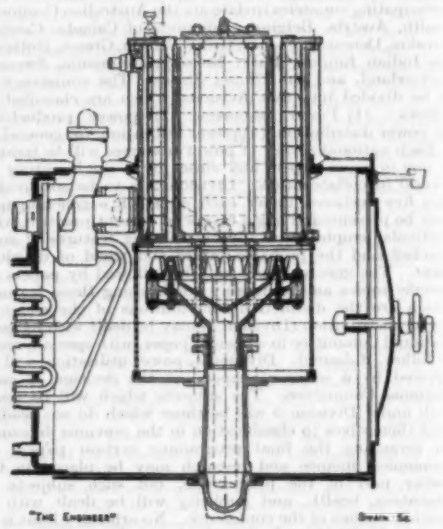
FIG. 2—OXYTOME ARRANGED FOR MAKING FORMED CUTS

The upper arm has a quick hand adjustment and also a power traverse along the gantry, and the saddle has quick hand adjustment and power cross traverse along the arm. Pivoted to the saddle is a swivelling slide carrying a feed plate which makes connection with the blow-pipe, and thus communicates automatic feed to the jet. The swivelling slide is graduated and is used for angular cuts. The controls are placed at the end of the upper arm and at the end of the swivelling slide. The variable feed is obtained by friction discs and can be regulated with great exactitude. A ¼ horse-power electric motor mounted on the upper arm drives the whole mechanism.

By the means described any straight or circular cut can be made by a direct connection between the feed plate on the swivelling slide and a peg on the blow-pipe saddle. Fig. 1 illustrates the machine in this condition. For formed cuts the template is mounted on the holders above the upper arm—as shown in Fig. 2. A pillar is fastened on the blow-pipe saddle and a steel peg at the top slides along the edge of the template, the whole being pulled by the upper arm through the agency of a pivoted tow-bar. Weights are provided to keep the guiding peg in contact with the former, and are so arranged that the jet can follow completely round any form without the work having to be reset. The former can be swung up out of the way to allow the work to be lifted on or off the machine by a crane. Generally speaking, it is not necessary to clamp the work, as there is no actual cutting pressure exerted upon it.

A New Feed-heater for Small Locomotives.

In a recent issue of the German technical paper *Verkehrstechnik*, an account was given of a new type of small locomotive which has been built by the firm of A. Borsig, Berlin-Tegel, and placed in commission on the Voldagsen-Duingen-Delligsen light railway. It was designed to be run single-handed, and several new features have been introduced. Chief among them is the smoke-box feed heater, shown in the accompanying illustration. The hot gases enter the heater through a circular perforated cylinder, and are entrained by an annular series of steam jets placed below the vertical smoke tubes of the heater. The heater water space has a series of light horizontal baffles, which are shown in the illustration reproduced. It will be seen that an internal smoke tube type of superheater is also fitted. The feed water, delivered by an automatic pump, first passes through an exhaust steam feed heater of the Knorr pattern, where its temperature is raised to about 90 deg. Cent. It then circulates through the smoke-box feed heater, and its temperature is further increased up to 130 or 140 deg. Cent.



FEED HEATER FOR SMALL LOCOMOTIVES

Compared with the old wet steam type of locomotive commonly in use on light railways, the new locomotive is stated by the makers to show a considerable saving in fuel. A four-coupled normal gauge locomotive will use about 13 kilos. of coal per kilometre, whereas the new locomotive is said to require only 7.5 kilos. If the saving due to single-handed working also be added, a gross reduction of 50 per cent. in fuel and wages is claimed. The introduction of this type of locomotive has enabled the German railway authorities to improve the service on the light railways; but in spite of increased traffic the passenger fares are still too low to permit of overhead expenses being met.

Industrial League and Council.—The series of weekly lectures arranged by the Industrial League and Council for the improvement of relations between employers and employed are being resumed at Caxton Hall on October 10th at 7.30 p.m., when the Right Hon. T. J. Macnamara, P.C., will speak on "Unemployment and the Coming Winter." The chair will be taken by the Right Hon. G. N. Barnes, P.C. This lecture will be followed by others on "The Bankruptcy of Capitalism," by Mr. Tom Kennedy, on the 17th; "The Making of Wealth," by Sir Ernest J. P. Benn, Bart., on the 24th; and "Some New Factors in Industry," by Mr. F. S. Button, J.P., on October 31st. Admission is free to all meetings and tickets are not necessary.

Swiss Trade and Industries in 1922.—We have just received a copy of the "Rapport sur le Commerce et l'Industrie de la Suisse en 1922," which is published by the "Vorort de l'Union Suisse du Commerce et de l'Industrie"—the Association of the Chambers of Commerce in Switzerland. The report opens with a statistical portion, in which are set out in tabular form figures which enable a clear appreciation of Swiss economic conditions to be made. Information is also given concerning the state of the labour market. Then follows a series of reports which deal separately with Switzerland's various industries and articles of commerce, including both imports and exports; with the production and distribution of electrical energy; with traffic and transport, &c. Particulars are also given of institutions for commercial and professional education and of the work carried out during the year at the St. Gall experimental station. The book is full of interesting information and should prove of considerable value to those having commercial dealings with Switzerland.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Birmingham Quarterly Meeting.

The quarterly meeting of ironmasters on the Birmingham Exchange, which took place to-day—Thursday—proved, I am sorry to say, like the last, disappointing. Confidence was conspicuously lacking, owing, no doubt, to the obscure and perplexing outlook. There was manifest a widespread distrust of the future. Midland iron and steel masters were not adventurous enough to forecast what the effect of developments in the Ruhr will be. The reports concerning vast stocks of material awaiting liquidation as soon as things can be straightened out in the occupied territory came in for much attention. It was stated in some circles that reports indicate that the Ruhr has practically no iron or steel suitable for this market, for, if reports are to be trusted, the material is in such a condition that it will have a very limited utility. Other reports being at variance with this view, general distrust is the result. Another matter which came in for much attention was the question of fuel supplies, and ironmasters on 'Change would like to have known whether the settlement in the Ruhr will infuse such new life into continental trade that industrialists there will be content to go on paying high prices for British fuel in order to get their products on the market. The prevailing opinion was that continental coke demands will shrink to normal proportions before long, it being hardly conceivable that our competitors on the Continent can hope to get their industries down to steady going again on the strength of British fuel. It is greatly to be hoped that this will prove to be the case, for it is hardly to be expected that coke makers will reduce home prices while they can dispose of their output at higher figures to the foreigner. Iron and steel manufacturers in this area, in common with those in other parts of the country, have sacrificed their profits in the hope that the tide would turn, and they see little chance of getting back to an economic basis, except by way of lower production costs. Though fuel costs have fallen a few shillings during the quarter, the reduction has been too slight to alter the situation materially. Moreover, it is only with great difficulty that blast-furnace owners can get supplies of coke, even at to-day's prices, and on 'Change to-day they expressed their gratitude to those coke suppliers who have not forgotten in this sudden flow of business from the Continent that it is the home consumption that is the backbone of their trade. Relief in taxation and cost of transport and stabilised conditions the world over are, of course, necessary to a real recovery of trade, but there can be no doubt that cheaper fuel would help in some measure to get ironmasters out of their present predicament.

Market Situation.

Though the third quarterly meeting of the year finds business on possibly a more stable footing than the second did, it is questionable whether the improvement in iron and steel business which has been going on for the last month is maintained. At any rate, it has not developed in a manner sufficient to give producers grounds for increased satisfaction. Judging from the business transacted to-day and the inquiries in the market, heavy structural steel is, after sheets, the most hopeful branch, and inquiry has been enlivened by the belief that the end of the dispute with the boilermakers is near at hand. Values which were firm in most departments of the market tended to ascend rather than descend, though there were no actual price alterations. Producers are using every endeavour to get trade on the move, but buyers give them little encouragement, and are disinclined to surrender control of prices. Consequently, little actual business was put through at to-day's meeting, and producers were a little discouraged. They firmly refuse, however, to be pessimistic, and though they cannot see at all clearly ahead, they are looking for a decided improvement in business before the quarter is out.

The Bar Iron Trade.

There was at to-day's quarterly meeting a slightly better feeling manifest in the Staffordshire bar iron trade, and ironmasters reported more business than for some time past. The trade usually benefits at this time of the year by some buying on behalf of warehousemen in the country districts, and the demand from this quarter promises to be fairly up to the average. Marked bars are in improved demand, and prices remain unchanged, though the disparity between them and second-class iron is greater than is usual. Medium bars have in some instances changed hands at £11 10s., though the nominal minimum is £12. Staffordshire makers of nut and bolt bars adhere to their quotation of £10 15s., and they report a rather brisker demand. This they are getting the full benefit of, as foreign competition is hardly in evidence at all just now. The few quotations which have come through from Belgium this week show an advance of 7s. 6d. per ton on last week's figure. They now ask £9 delivered for iron suitable for the nut and bolt industry. There remains a good deal of idle plant in the Staffordshire manufactured iron trade, and judging from the reports prevalent on 'Change to-day, the outlook is none too rosy.

Business in Steel.

The steel branch of the market has improved a little, specifications being somewhat more numerous, especially on account of heavy structural material. The prices of finished steel, which have been reduced about 10s. per ton during the past quarter, were not interfered with at to-day's meeting. The country warehouses are replenishing their stocks, as is usual at this time of the year, and fair quantities are being sold through Birmingham merchants. The larger consumption by the makers of galvanised sheets accounts for added firmness in the market. The Welsh works are busy, and are not now pressing their steel upon the Midland market. A notable improvement also is the rise in steel scrap values, to which I referred last week, and which has resulted in an added firmness in billet values. During practically the whole of the past quarter, this material has been stagnant, and those who have stocks are now holding them in the hope of still better prices in the near future. The recognised price for mild steel billets remains at £7 15s., but few firms are ready to sell at this figure, Midland concerns, especially, asking £8 and upwards. On the other hand, some of the big steel works have this week, so it is reported, accepted as low as £7 12s. 6d. Foreign competition, whether for semi-finished or finished material, is practically non-existent. Belgian and Lorraine competitors are not able to quote prices that command business here. Some of the few offers received here this week are well above local makers' prices. Apart from exchange fluctuations, the trend of continental prices is upward.

Galvanised Sheets.

The most hopeful section of the market is undoubtedly that of sheet iron and tin-plates, in which the mills are assured of good business for some time to come. Prices are being handled cautiously, the anxiety being general not to check the improvement in demand, which is both on home and export account, by premature advances. Not only for light gauges is the demand brisk, but sales of 24 gauge galvanised corrugated sheets are being made in increasing numbers on the basis of £19. Occasionally, a premium is paid where early delivery is called for. The reported amalgamation of two large Welsh groups of tin-plate makers excited some interest in Midland circles, particularly in view of the success with which the tin-plate trade is recovering its pre-war connections.

Firmer Pig Iron Values.

Blast-furnace owners are putting up a strong fight for more remunerative prices for their product. During the past three months they were forced to give way, notwithstanding the stubbornness with which coke prices were maintained. For the greater part of the quarter there was gradual retrogression in pig iron. Now, however, makers seem determined not to give way further. The reduction of 2s. per ton in coke prices has been made the occasion for renewed efforts on the part of buyers to depress pig iron prices further, but so far smelters appear to have successfully resisted these efforts. The concession by the oven men, in the view of smelters, is merely an instalment towards reimbursing them in the matter of sacrifices to which they have lately submitted. It is pointed out that the cut has been more than discounted by recent concessions in iron prices, and coke users are none too confident that the lower price will be continued, in view of the large foreign demand. There is still a good deal of pig iron inquiry in the market, with some resulting business, but this is chiefly for foundry irons, forge material showing decided weakness on account of the poor demand from the Staffordshire ironworks. North Staffordshire No. 3 foundry iron was quoted to-day £4 10s. to £5, Northamptonshire £4 10s., and Derbyshire £4 11s. Forge material was offered at £4 for Northamptonshire and £4 4s. to £4 5s. for Derbyshire brands. Some Northamptonshire makers might have been prepared to shade their figures, but the position was fairly solid. There was no indication on to-day's market that any appreciable amount of business would have been released if smelters had accepted lower prices.

Rolling Stock.

The rolling stock concerns in this area continue fairly well employed, though there is still a large amount of unemployed resources in the industry. On 'Change to-day it was reported that some good orders for iron and steel should shortly be forthcoming from this quarter, as many local firms are to participate in orders for freight and passenger vehicles for the South African railways and locomotives for various destinations abroad. Though locomotives are not built in the immediate area, a considerable amount of incidental work is done in Birmingham and the Black Country, as in the drawing of copper tubes, the making of fire-boxes, &c. I am given to understand that a hundred big bogie wagons for the grain trade in South Africa are to be built at Oldbury, and that fifty passenger coaches for the railways of the same country are likewise to be constructed at local works.

Structural Engineering.

Structural engineers in the Midlands are rather better off for work than they were a few months ago, and the demand for heavy structural steel is increasing. Black Country firms are engaged on bridgework and other classes of work in connection with the organisation of the home railways. There is also some activity on account of development work abroad. At one well-known South Staffordshire iron and steel works, a large proportion of the output is in respect of waterworks and railway enterprises in the Colonies.

Cannock Chase and the Wages Question.

It would appear that there is a prospect of something in the nature of a struggle between the coalowners and the miners during the coming months, but the opinion held here is that there is little likelihood of a stoppage in the industry. In the Cannock Chase coalfield, the miners are emphatic in supporting the continuance of the wages agreement, though they are anxious to secure, if possible, certain alterations. In this coalfield, although the wages of the miners are not as high as the men would like them to be, the various grades of pit workers have the satisfaction of knowing that they are doing much better than many thousands of miners in other parts of the country. The minimum wage of stallmen in the Cannock Chase area at present stands at 10s. 5d. per day, compared with 9s. 1d. in October, 1922. According to the employers, the average earnings per shift of the miners in the eastern federated area, which includes Cannock Chase, for September and October, is 11s. 2d. each, as against 6s. 7d. in 1914. That the miners in this coalfield have every reason to be satisfied with the existing conditions should be obvious, especially when one points out that in South Staffordshire and Salop the average wage is 7s. 6d. per shift.

The Workless.

Unemployment in the Midlands area has unfortunately failed to continue its downward course, and the latest returns show a slight increase in the number of persons unemployed, the total being 168,815 as compared with 168,430 for the previous week, an increase of 385. There are now out of work in this area 122,408 men, 4430 boys, 36,414 women, and 5563 girls.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

General Conditions.

The markets in Lancashire are still without any of those signs of improvement which are occasionally reported from other districts, and the feeling here is, if anything, more sceptical about them. All the Manchester markets are, of course, more under the influence of the depression in the cotton trade than are those of Glasgow, Sheffield or the North-East; but making every allowance for this fact, it is difficult to believe that any real improvement in the other districts would fail to affect Manchester. No doubt some fairly good orders have been secured lately, such as that for steel rails, which has set the Barrow steel works going again, but the general condition of the iron and steel trades is not seriously altered. The trouble about the steel orders is that although they provide work, they do not provide any profit. So far as an outsider can see, no progress has been made in the direction of re-establishing normal economic conditions in Middle Europe, and until this is accomplished one cannot believe that trade can revive to any serious extent.

Metals.

The markets here for the non-ferrous metals have been dull and quiet, and the business being done is well below the average. Copper prices looked like making another low record, but they have rallied a little. The outlook in the copper market is, however, not such as would induce consumers to buy any more than is required for prompt needs. It seems to be generally admitted that the production of copper is well in excess of the present rate of consumption; and until Germany is again put on her feet as a copper-consuming country, there is no probability of restoring the balance between output and consumption, unless, of course, American copper producers are prepared to sacrifice themselves for the good of the market. The domestic consumption of copper in the United States is not equal to normal figures, although America, as the one wealthy country in the world, might have been expected at least to maintain her home trades. The disinclination of the American consumer to buy more metal than is wanted for immediate use seems to be much the same as it is here; and yet copper prices must be at or near the bottom. There are pessimists who point out that copper, in the past, has been very much cheaper than it is at present; but those times of abnormal cheapness were very exceptional, and did not last long. The markets here for scrap copper and non-ferrous metals are dull but steady, and it may perhaps be taken as a sign that prices are safe that scrap has remained practically unchanged for several months, with the exception, of course, of those classes of old copper which move with refined ingots. Tin has had a period of firmness and rather higher prices; but it is to be noted that one result of the rise above £200 has been larger selling from the East, in view of the reduction of the Government holdings in that region. America is now fairly well provided with tin, and may conceivably keep out of the market for a time. If so, there may be a difficulty in sustaining the present prices. Lead has again been a fairly strong market, but spelter is rather easy. It may be pointed out that at the end of August the difference between lead and spelter was £8 10s. per ton, and that it is now only about £6.

Pig Iron.

There is very little sign of interest here in the foundry iron market, at any rate amongst consumers; although it is said that in Cleveland and in Glasgow there is more life and rather more actual buying. There seems to be a theory in the former district that the price is now at the bottom; but one finds a difficulty in believing this theory so long as Cleveland iron is so much dearer than the Midland irons. However this may be, there is no such feeling here, and consumers are waiting to receive the concessions which they claim are due, because of cheaper Midland furnace coke. Sellers of foundry iron maintain that the easier coke prices have already been taken into full consideration, and the price of Derbyshire iron is still based on 91s. at the furnaces. Northamptonshire No. 3 iron is quoted at 90s., but this is now too dear for the Manchester market; and in practice South Lancashire is confined to Derbyshire iron with some occasional lots from Lincolnshire, which are so intermittent as to be negligible. The poor condition of the foundry industry here may be judged by the fact that with these very restricted supplies of iron there is still plenty for all requirements. Scotch pig iron is a little firmer at the furnaces, and the price here has been raised by 1s. or 1s. 6d.; but there is so little demand for it, and founders are so sparing in their use of dear iron, that the difference is quite negligible. There is said to be some accumulation of pig iron at the Derbyshire furnaces, but this is not yet sufficiently pronounced to weaken the market. The general policy of consumers here is to wait and see what is going to happen to the Midland coke prices.

Steel.

The demand here for manufactured steel is, if anything, rather feebler than it was, and the market is

not affected by reports of better export orders. So far as one can see, these orders are taken at "cut" prices, and it is a little too much to expect people to believe in a revival of trade when it is only unprofitable trade that is reviving. There is a hope that things will be better when the boilermakers get back to work, and possibly there will be some little spurt; but it is difficult to believe that it can have any permanent effect, or that trade can improve until Europe is in a more settled condition.

Scrap.

The demand here for foundry scrap remains most unsatisfactory. Dealers say that "they cannot give the iron away," which is, of course, an exaggerated way of describing utter stagnation. The nominal prices for good to best cast scrap are from 80s. to 85s. per ton. Steel scrap is not inquired for, and dealers in Lancashire are now offering only 60s. on trucks for heavy steel melting scrap and 52s. 6d. per ton for turnings. The malleable ironworks are getting all the heavy wrought scrap they want at 75s. to 80s. per ton.

Barrow-in-Furness, Thursday.

Hematite.

There is more life in the hematite pig iron market than there was a few weeks ago. There are signs of a gradual improvement, but the present business is still nothing but moderate. Competition is keen, and makers are cutting prices to the lowest level, and only allowing themselves a very narrow margin. This competitive business has developed recently. A furnace has been put in at Cleator Moor after being idle for some time. There is a bigger consumption locally on steel account, and there is not a large quantity going into stock now. The continental trade is only moderate. A cargo left Barrow for Treport last week, and there was also a part cargo for Ghent. Orders are held for delivery at other continental ports, but they do not amount to much. American business is quiet. Trade with Scotland has not improved as yet, but there are hopes of better business when the boilermakers' trouble is over.

Iron Ore.

There is very little difference in the iron ore trade, but as soon as the local iron trade improves this branch of industry will receive an impetus. Very little is going out of the district. A part cargo of ore went to Ghent last week. Not much foreign ore is coming in, only one cargo from Kirkenes arriving last week.

Steel.

There is an improvement in the steel trade, and both the Barrow and Workington rail and merchant mills are engaged. The Barrow mills have orders which will take them into the middle of next month, and it is possible that there will be more orders booked. Competition is keen, and the prices offered in some cases do not yield a margin at the present cost of production. The hoop and section mills have plenty of work.

SHEFFIELD.

(From our own Correspondent.)

"Leaving the Dip."

The most hopeful thing that has been said officially about the state of the steel trade this week was a remark by the chairman of the United Steel Companies, Limited, at the annual meeting on Monday. Having referred to the falling off in demand that had been experienced since April, to the fact that prices had fallen substantially, and that it had been necessary to reduce the amount of plant running, he added: "Nevertheless, considerable business is in hand, and from the large inquiries we are receiving we are hopeful that we are leaving the dip in the curve and are on the up grade again." One of the principal industries in which the United Steel Companies are engaged in this district is the making of basic steel. A large tonnage is still being melted, and the output is probably 70 per cent. of full capacity. Another large works devoted mainly to basic steel is that of the Parkgate Iron and Steel Company. Here several furnaces are idle, and there is a scarcity of new orders. Generally speaking, indeed, the buying of billets shows a drop, and some of the furnaces are only kept at work in the expectation of an early revival. It is hoped that the prospects of a speedy settlement on the Ruhr will improve the outlook for Europe generally. In spite of the slowness of the demand, billet makers are holding their prices firmly.

Ship and Railway Steel.

The *Journal* of the Sheffield Chamber of Commerce states that "ordinary ship steel is held up by the continued dispute with the shipyard platers and riveters, but this branch of industry may open out very well when the lock-out is ended. There has been little building for two or three years, and many old boats stand to be broken up and replaced. Railway material is a fairly healthy line, considerable quantities of axles, tires, springs, &c., are going out, good orders have been booked for rolling stock, and heavy contracts may be expected shortly for general railway equipment. Castings for marine engineers are affected by the shipyard trouble, but there is more doing on account of electrical engineers, with still larger orders pending. As soon as arrangements can be made, this locality should be favoured with big orders from Japan. Enormous quantities of steel and engineering products will be needed to repair the damage done by the earthquake catastrophe. The work will, no doubt, be divided mostly between British and American manufacturers."

Acid and Crucible Steel.

If the open-hearth furnaces producing basic steel are but indifferently employed, on the whole, the state of things in the acid steel trade is worse. There has been no bulk buying of billets for two or three months, and a large proportion of the furnaces are standing idle. The crucible steel trade continues poor. There are few large orders to be picked up, and what business is placed is unevenly distributed. During the past week, however, there have been a cheering number of inquiries for ferro-alloys, such as are used in the making of special steels. Tungsten and chrome are wanted by several firms, and this suggests the probability of improved conditions at the melting furnaces before long. The slump in trade has had very serious effects on the progress of electric steel melting. Two or three years ago, about sixty electric furnaces were regularly at work, but the number has now been reduced to one-tenth. Some of those which continue in operation are giving good results on steel castings. Others are producing stainless iron and steel, and alloy steels for motor work. Of the remainder, many are idle, and some have been sold. The motor trade is making a useful demand for alloy steel, while good business is being done in motor parts and accessories.

Admiralty Requirements.

Tenders for a year's supply of knives, spoons and forks are being invited by the Admiralty. Considering the reductions in the *personnel* of the Navy since the war, the quantities are fairly large. The principal items specified are 31,000 table forks, 30,000 tablespoons, 24,000 dessert spoons, and 26,000 teaspoons, all of nickel silver unplated; also 32,000 table and dessert knives with plated handles, and a number of entrée dishes and other articles of hollowware. Both the plate and cutlery trades are only enjoying a moderate amount of activity, and the Christmas season orders which are coming forward are only on a limited scale. The falling away of German competition is benefiting the cutlery trade, especially in the pen and pocket knife and scissors branches. There are also large inquiries in Sheffield for bent manicure scissors, which have for many years been practically a German monopoly. For a considerable time, the Sheffield cutlery industry has been suffering terribly through the dumping of German products, and it is being recognised that a strong effort should be made to safeguard the local trade. Absence of clear indication of origin is one of the complaints against the imported article, and Sheffield manufacturers and workmen are discussing the question of taking concerted action with a view to preventing the sale of unmarked German goods in England.

Valuable Products from Refuse.

A good deal will probably be heard in the future about the new refuse disposal works which the Sheffield Corporation has just erected and brought into use. The works aim, not only at disposal, but also at recovery of valuable products, and they are succeeding to a remarkable extent. The refuse dealt with is of the kind known as "dry," and includes the vegetable matter, rags, bones, paper, cinders and tins that people throw into their ashbins. Every day in Sheffield about 500 tons of this stuff is collected by electric vehicles and delivered at the works. From the hopper into which it is first dumped, it is lifted by a steel grab, and fed into smaller hoppers, from which it is taken to a system of screens, which divide the smaller material into dust, fine cinder and coarse cinder, whilst the bulky refuse is discharged on to a conveyor which delivers it on to a picking belt, where rags, bones, tins and paper are picked off for future treatment.

Boilers Fired with Refuse.

Every one of these classes of articles is made to serve a useful purpose. Perhaps the most striking feature is the use that is made of the coarse cinder. This goes through a series of washers in which the lighter, burnable material is separated from the heavy, incombustible *débris*. This *débris* is tipped, and the washed cinder is used to raise steam for driving the electrical plant at the works. There are two Stirling water-tube boilers, driving three 250-kilowatt electrical sets. No coal is bought. The boilers are fed entirely with the refuse, and enough electric current is produced, not only to run the plant at the works themselves, but also to charge the batteries of all the electric vehicles which are used for the collection of refuse, and there is still a surplus which is sent to the baths and other places for steam raising. The fine cinder is mixed with a proportion of pitch and made into briquettes. The dust has a high agricultural value, and is sold as a substitute for stable manure. The tins, of which there is an enormous quantity, and which, of course, consist chiefly of iron, are sold to the steel works as scrap for use in the making of low-grade steel. At present they are sent out with their tin coating, but a detinning plant is being built at the works for the purpose of making them more suitable for the steel trade. The bones are ground up—though not at this works—for manure, and the paper goes to the paper mills. A garage is now being built to house seventy-five electric vehicles. The total cost of the whole establishment will be about £250,000.

Chesterfield Gas Extensions.

The Chesterfield Corporation is proposing to expend £22,000 on the renewal of one-half of the coal-carbonising plant at its central gasworks. At a Ministry of Health inquiry into the matter, it was stated that the present capacity of the works was 1,000,000 cubic feet per day, and that the demand was rapidly growing. The present plant was out of date, and practically worn out. It was proposed to adopt the horizontal type of retort for one-half of the plant, which would produce 1,250,000 cubic feet per day. The interesting question of using coke-oven gas was raised by Mr. Charles Markham. On behalf of the Staveley Coal and Iron Company, of which he is the chairman, he offered to supply the Corporation with all the gas it required from the coke ovens at Staveley Works. The price would be about 1s. per 1000ft.—which is what Chesterfield is already paying for coke-oven gas from Grassmoor—and Mr. Markham said that the Corporation could not make it for anything like that. Mr. H. Davies, the Corporation's gas engineer, pointed out several difficulties in Mr. Markham's plan. One was that the Whittington gasworks, to which that gentleman proposed to deliver the coke-oven gas, was a small one, and it would be necessary to provide increased storage accommodation there if the Staveley supply was accepted. With regard to the price, he believed it would be possible to reduce the cost of production at the central works, with the modern carbonising plant, to less than 1s. per 1000ft. There the matter remains for the present. The Inspector will make his report, and the outcome of the inquiry will be awaited with interest. While on the subject of gas, I may mention that the Sheffield Gas Company has decided to prepare a scheme of co-partnership for its 1200 employees. This is based on a clause in the company's recent Act, which provides that, if the price of gas is sold cheaper than the basic rate of 7d. per therm, three-quarters of the extra profit shall go to the consumer, one-eighth to the employees, and one-eighth towards an extra dividend for the shareholders.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Brighter Outlook.

Although it would be incorrect to speak of a "revival" in the iron and steel trades of the North of England, there is nevertheless a definite improvement in the position generally, and the prevailing opinion is that at long last the depression is fading and that the trend in all directions is towards a return to something like normal activity. It is confidence which has hitherto been lacking. Upon a steadily falling market buyers have been afraid to operate, and have simply been purchasing from hand to mouth. Now there is a significant change. Quite a number of contracts have been placed this week for delivery to the end of the year, and there are actually inquiries circulating for the first quarter of 1924.

Cleveland Iron Trade.

The improvement in the Cleveland pig iron trade is well maintained. Home and foreign markets are broadening out, buyers are less insistent about making forward purchases, and whilst the actual volume of sales does not perhaps much exceed the output, the probability is that a settlement of the boilermakers' dispute would bring in such a spate of orders as to revolutionise the position by rapidly liquidating stocks of iron and necessitating the starting up of more blast-furnaces. Consumers have apparently become convinced that prices have touched bottom, and they are ready to place business in fear of prices stiffening. The fall in coke prices has afforded temporary relief to the ironmaster, but during the past few days there has been a big export inquiry, and the fuel market displays a much firmer tendency. Thus the cheaper coke supplies may soon cease; but the shortage of fuel on the Continent and the rapid rise in coke prices there places local producers in a relatively favourable position, as is indicated by the steadily growing demand from the Continent for Cleveland iron. Some of the local firms still adhere to 96s. per ton for No. 3 G.M.B. Cleveland pig iron, but sales have been recorded at 95s. 6d., and that may be taken as the market quotation. No. 1 is as scarce as ever and firm at 102s. 6d., whilst No. 4 foundry is 91s., and No. 4 forge 88s. 6d.

Hematite Pig Iron.

There is a much brighter tone in the East Coast hematite pig iron trade. Orders both on home and foreign account are coming forward in encouraging volume. Some good sales have been made to Belgium and Italy, as well as Germany. The general market quotation for mixed numbers is 99s., and No. 1 is offered at 99s. 6d. to 100s. per ton.

Ironmaking Materials.

Imports of foreign ore continue on a large scale, but new business is very scarce, and best Rubio ore is still offered at 23s. per ton c.i.f. Tees. The strong continental demand for fuel has stiffened the price once more, and good medium Durham furnace coke is now quoted at 30s. per ton delivered at the works.

Manufactured Iron and Steel.

More encouraging accounts are given of the manufactured iron and steel trade. Orders are coming in more freely and the outlook for the winter would be quite bright if only the shipyard dispute was speedily settled. There is an enormous demand for galvanised corrugated sheets, but most of the makers are so full up with work that they are not in a position to accept orders for delivery before 1924. Contracts, however, are being booked for execution after the turn of the year. There is no change in prices.

The Coal Trade.

The Northern coal market continues to move along steady lines, which from the colliery point of view is very satisfactory. All the strengthening influences which were recently at work are still in active operation, so that the improvements observable during the last week or two are fully maintained. So far as appearances are concerned there is at present every probability of a further advance in prices. It would appear that forward contracting, which has been in abeyance for some little time past, is likely to be proceeded with in a more or less earnest fashion. Some buying for next year has already taken place and other contracts are under consideration at fairly satisfactory figures from the colliery point of view. The inquiry from abroad is said to be fairly extensive. There are uncertainties and not a few anxieties, due to the extremely unsettled state of affairs in Germany and elsewhere; but despite this, there are indications of an expanding trade with most of the usual West European countries being booked up in the course of the next few weeks. For the Mediterranean localities not much is going forward at the present time. The question of shipping facilities is still a very vexed one. The congestion at the docks and at Dunston, in particular, is as bad as ever, so that if the output could be accelerated or enlarged by the collieries

the coal could not be cleared quickly enough to prevent hopeless confusion. The Northumberland steam coal position is very strong; the entire output is bespoken for the month, with the result that only second-hand dealing is possible for practically every class of best steams. Gas coals have not improved to the same extent, but they are very steady for the best classes, and are improving in the case of seconds. The coke position is as firm as ever, with foundry sorts scarce and strong.

Blast-furnacemen's Wages Reduced.

The ascertainment issued by the Cleveland Ironmasters' Association certifies that the average net selling price of No. 3 Cleveland pig iron for the past quarter was 99s. 7.72d. per ton, as compared with 112s. 1.64d. for the previous quarter, a reduction of 12s. 5.92d. per ton. In accordance with the sliding scale arrangement the wages of blast-furnacemen are reduced by 12.50 per cent., which will leave them still 38 per cent. above the standard. The reduction takes effect from the 7th inst.

Cleveland Miners' Wages.

Computed on the ascertained price of pig iron for the past quarter, wages in the Cleveland ironstone mining industry should have fallen by 15.62 per cent., but a reduction of 13 per cent. has been agreed upon by the mineowners and miners' representatives. This will leave wages at 98.5 per cent. above the base rate. The figure represents an advantage of 5 per cent. more than the old sliding scale would have yielded. The rate of pay for men engaged in timbering at the face also received attention. Certain offers were made by the employers, but did not secure the approval of the men's representatives.

SCOTLAND.

(From our own Correspondent.)

Dreary Outlook for Winter Months.

There is still no tangible improvement in the industrial situation in Scotland, and with time wearing on, prospects for the winter become less and less satisfactory. The boilermakers' dispute has lasted so long now that it is questionable if an early settlement would make much difference to trade this side of the New Year. Many orders have either been hung up or cancelled, and some time must necessarily elapse before works reach steady operation. Scotch manufacturers are faced with heavy oncosts, and do not seem able to meet other competitors in the question of price, and works in this district are barely getting their share of the restricted amount of business going the round at present. Apart from foreign competition, local makers find great difficulty in quoting prices similar to those named by English works. The shipbuilding outlook is most unsatisfactory. At the valuation court during the past few days a number of shipbuilding concerns were asking for reductions, and judging from the evidence given on behalf of the claimants, the outlook is about the worst in the history of this industry. In the opinion of one or two, it seems extremely doubtful if the capacity of existing shipbuilding yards will ever again be fully taxed. A settlement of the boilermakers' dispute would certainly produce a better situation up to a point, but a considerable time would be necessary before any real progress would be noticeable. The state of unemployment is becoming worse with every week that passes, as may be computed by the fact that in Greenock alone, for instance, the out-of-work or partially employed population is estimated at about 10,000 persons. Similar conditions prevail over practically the whole of the shipyard area, and the steel works and ironworks are similarly affected, although perhaps to a lesser degree.

Pig Iron.

Apart from a slightly larger turnover in hematite, there is nothing of fresh interest in the pig iron trade. Foundry qualities have few buyers and the restricted output is more than sufficient to cover requirements. The tendency of prices is weaker, but in the absence of business the market is not tested. It seems likely, however, that a good order could be placed below present quotations.

Steel and Iron Unchanged.

The course of business in the steel and iron trades continues to present a great scarcity of fresh orders for almost all classes of material. Steel makers have few inquiries for plates or sections on home account, and have great difficulty in regulating their prices in relation to competitors' quotations in the foreign trade. Sheet makers are still satisfactorily placed with orders for the lighter gauges, but would welcome an improvement in heavier sheets. The situation at the bar iron works is of a similar nature. Buying is of a very hand-to-mouth description on both home and export account. Iron bars are still quoted on the basis of £12 per ton for Crown quality for home delivery, while the export price fluctuates round about £11 per ton. In the re-rolled steel department, poor demands are experienced for bars and small sections, and as competition from abroad becomes keener, prices are weakening. Galvanised sheets are comparatively busy, partly, it is said, on Japanese orders.

Engineering Contracts for Kilmarnock.

Contracts of considerable importance to Kilmarnock have been placed with Glenfield and Kennedy, Limited, on behalf of the Governments of India and Siam. The contracts are for an irrigation barrage on the Sarda canals system, Punjab. The order includes fifty steel sluice gates, with the necessary gear. The cost of the material alone in the Indian contract is estimated at £80,000. The contracts will provide work for about 2000 men over the winter at least.

Coal: Increasing Export Demand.

A fairly satisfactory position exists in the export branch of the Scotch coal trade. In Lanarkshire, the Lothians and Fifeshire, round fuels are in better export request at stiffening prices, and washed nuts also are well booked. Best ells, steams and splints have improved during the past few days, and in the Lothians fresh bookings can scarcely be arranged under ten days in either large or small coal. Third-class Fife steams have been busy for some weeks, and now the first-class qualities have come into line. The pressure has improved so much that at Methil a loading turn of fully a week is general. Small steamers are not too plentiful, and shipments are consequently curtailed a little, but the aggregate returns amounted to 351,911 tons, against 376,041 tons in the preceding week, and 355,659 tons in the same week last year. The local demand for industrial fuel remains low, but gas and electricity and household requirements are increasing as the season advances. Household fuel is now dearer, the Glasgow price for best qualities being about 2s. 4d. per cwt. bag. Ordinary qualities can be bought from 1s. 11d. to 2s. 1d. per bag.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

The conditions prevailing in the steam coal trade display extremely little change as compared with a week ago. The general inquiry has not expanded in the slightest degree, but, if anything, the demand from the Continent is quieter, and even lower prices have been touched for supplies for prompt loading. Prices for the majority of collieries are now certainly down to the level of costs of production, and in many instances are below it, but it is better for collieries to endeavour to keep their pits working with some degree of regularity rather than to suffer stoppages, which are more costly. The continental demand for coal has been on quite a negligible scale, and this is not surprising in view of the breakdown of German passive resistance in the Ruhr and the prospect of a resumption of Reparation deliveries. In these circumstances, consumers in France, Belgium and Italy are naturally desirous of waiting in order to see what transpires, and therefore so far as coals from this district are concerned, they prefer to mark time and refrain from buying. French railways, however, form an exception, inasmuch as there is an inquiry from them for 30,000 tons of large and small coals for delivery up to the end of the year. French railway requirements are, however, likely to be rather curtailed, for the reason that only a few weeks ago the Nord and Etat Railways purchased 150,000 tons of American coals at the price of 6.15 dollars per ton, c.i.f. Havre/Rouen in the case of the Etat and c.i.f. Dunkirk in the case of the Nord. These coals are for delivery between now and the end of the year. It has been a matter for some surprise that American coals should have been purchased, in view of past experience of the quality of the coals received from America. The price which the Americans have accepted is, however, a pretty severe cut, and consequently in this respect spells no good for this market.

Miners and Wages.

The result of the meeting of the National Coal Board last week, when the owners' representatives declined to grant the requests of the men's leaders that there should be an alteration of the ratio of profits to wages and an increase in the minimum rate of wages prescribed by the national agreement, came as no surprise in this district. In South Wales the outlook is regarded as none too bright, especially as it is practically certain that the wage rate next month will show a reduction, and with the irregularity of work which has been experienced lately, will accentuate the feelings of dissatisfaction which prevail. One of the men's leaders has already stated that the miners will not for long put up with the present conditions, and the probability is that before long a special conference will be called to consider the position.

Colliery to Close.

At various times trouble has been experienced at the Nine Mile Point Colliery, owned by the United National Collieries, Limited, but few were prepared for the announcement which the directors made on Monday of this week that owing to the prohibitive cost of working the undertaking they find it impossible to carry on the colliery, and therefore they have no alternative but to close down at the end of the present month. Over 2000 men are employed at this colliery, which is one of the model undertakings in South Wales, but there has been a very severe falling off in the output.

Tin-plate and Steel Amalgamation.

Since writing a week ago, the most important amalgamation which has taken place in steel and tin-plate undertakings in South Wales has been foreshadowed, this being between Richard Thomas and Co., Limited, and the Grovesend Steel and Tin-plate Company. The former are the largest makers of tin-plates in the world, and the latter come second to them, so that the dimensions of the deal can be gauged. The position is that Messrs. Richard Thomas and Co. have made an offer to take over 80 per cent. of the shares of the Grovesend or the whole of the shares of the company. There appears to be no doubt that the acquisition will go through. The amalgamation has been brought about very largely to enable Messrs. Richard Thomas to secure an assured outlet for the steel manufactured and to consolidate the selling organisation. The combined undertakings will control from 40 to 50 per cent. of the mills in the tin-plate trade, have an output of about 15,000 tons of steel per week, about 150,000 boxes of tin-plates a week, and about 10,000 tons of steel sheets a month, while they will be the employers of well over 10,000 workpeople, apart from the men engaged in their collieries. The total capital of the combined concerns will be about £7,000,000, but it is understood that before very long there will be a further issue of capital.

Anthracite Combine.

It is reported that arrangements have been practically completed for the formation of a new Welsh anthracite combine, with a capital of over £1,000,000, to own and control the anthracite undertakings of which Mr. John Waddell, of Llanelly, is now the principal owner. Mr. Waddell has for many years been associated with the Great Mountain Colliery, and quite recently he acquired the Ammanford and Pontyberem anthracite collieries. It is understood that Sir H. M. Macneal, of Glasgow, and chairman of Mann, Macneal and Co., Limited, coal exporters, and Mr. D. Daniel, of Crynant, will be on the directorate of the new company, and that before very long a public issue of capital will be made.

Coke Workers' Wages.

The men engaged at the coke and by-product undertakings in South Wales have been granted an increase in wages of 5 per cent., which advance operates from October 1st to December 31st. A sub-committee, consisting of six members from the owners' side and a similar number of representatives of the men, has been appointed to inquire into the possibility of formulating a scheme for the establishment of a district board to deal with all matters affecting this class of workers.

Cambrian Combine New Manager.

Mr. H. H. Evans, of Cilfynydd, Pontypridd, who is the agent to the Albion Steam Coal Company, Limited, has been appointed as the general manager of the Cambrian Combine Collieries, in succession to Mr. Hedley Clark, who resigned at the end of last month.

Current Business.

Operations on the steam coal market continue to be very quiet in all departments. New business coming along is extremely meagre, and prices are, if anything, a shade lower than they were last week for supplies for spot loading. Tonnage arrivals over the week-end were better, but this fact has not made any appreciable difference to the general state of the market, though the collieries, which have improved their position from the point of view of ready tonnage, are able to withstand better the bear tactics of buyers. Many collieries have lately worked somewhat irregularly, and one result of this is that small coals have become rather less plentiful.

CATALOGUES.

Sulzer Brothers, 31, Bedford-square, London, W.C. 1.—Revised catalogue, Sulzer bore-hole pumps.

British Insulated and Helsby Cables, Limited, Prescot, Lancs.—Illustrated list of aluminium matting and sections and aluminium and copper sheets.

The Midland Electric Manufacturing Company, Limited, Barford-street, Birmingham.—Illustrated priced folder entitled "Something New in Switchgear."

CONTRACTS.

The Monometer Manufacturing Company (1918), Limited, of Savoy House, 115–116, Strand, London, W.C. 2, has received orders for its patented temperature-controlled lead melting furnaces and extrusion plants from Siemens Bros., the Macintosh Cable Company, and from Messrs. Polaus, of Derby, Messrs. Gamons, and Fullers Electric Company.

Glenfield and Kennedy, Limited, of Kilmarnock, have recently secured, against competition, an important barrage contract for H.M. Government of India (Irrigation) Department. The order calls for the supply of thirty steel sluice gates, each 50ft. wide by 11ft. deep; four steel sluice gates, each 50ft. wide by 13ft. deep; and sixteen steel sluice gates, each 20ft. wide by 6ft. 4in. deep; together with all the necessary gearing and other appurtenances for operating these units. The total weight of material to be supplied is over 2000 tons, and the value of it will be about £80,000 sterling. The same firm has secured what practically constitutes a repeat indent from the Royal Irrigation Department of the Siamese Government for two large barrage sluices, each 41ft. wide by 19ft. 8in.

Standard Twelve-ton Wagons.—We have received from the British Wagon Company, of Rotherham, an excellent fully dimensioned drawing and specification of a 12-ton railway mineral wagon designed to conform with the proposals issued by the railway companies in April last. The British Wagon Company does not make wagons, its business being the hiring out of vehicles; but it informs us that it undertakes inspection during manufacture. We are desired to say that copies of the drawing and specification will be sent to interested parties on application to the company.

A Trepanning Tool.—We have received from Fry's (London), Limited, of 46, Upper Thames-street, London, E.C. 4, a sample of a new tool intended for cutting comparatively large round holes in metal plates. It takes the form of a saw bent round into a hoop, so that the teeth are presented like those of a crown cutter. The saw is hardened after being bent, so that it retains its temper. It is gripped, by the back edge, between a collar and a boss on a spindle, while there is a pilot standing out in the centre. A hole has, of course, to be drilled for this pilot before the saw can be put to work. The tool can be used either in the lathe or drilling machine and is made with parallel and taper shanks. The saw we have before us cuts a hole 2¼in. in diameter through metal up to 1in. thick, but is said to be most useful on plates ¼in. and less in thickness.

Engineering Golfing Society.—The autumn meeting of the Engineering Golfing Society was held at Addington, on Wednesday, the 10th inst. There were forty-six competitors. In the morning, in the 18-hole medal round, the "Hele-Shaw" Scratch Challenge Cup and Memento were won by C. H. Hayward with a score of 76. In the First Division, the 1st prize was won by E. W. Timmis with 81—8=73, and the 2nd prize by G. N. Watney with 78—4=74. In the Second Division, 1st prize was won by W. L. Mansergh with 86—11=75, while for the 2nd prize there was a tie between F. Bolton with 88—12=76 and E. C. Stevens with 89—13=76. The prize for the best first nine holes was won by R. S. Tobey, and that for the best second nine holes by S. Price-Williams. In the afternoon the Foursomes for the "Hadfield" Challenge Cups and Mementos were won by E. C. Mackellar and Walter Phillips (all square), the second prizes going to C. H. Hayward and F. H. Hayward, 1 down.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	19/6 to 26/-
(1) Spanish	23/-
(1) N. African	23/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 5 0	—
No. 1 Foundry	5 3 9	—
No. 3 Foundry	4 18 9	—
N.E. Coast—		
Hematite Mixed Nos.	4 19 0	4 19 0
No. 1	5 0 0	5 0 0
Cleveland—		
No. 1	5 2 6	5 2 6
Silicious Iron	5 0 0	5 0 0
No. 3 G.M.B.	4 15 6	4 15 6
No. 4 Foundry	4 11 0	4 11 0
No. 4 Forge	4 8 6	4 8 6
Mottled	4 7 6	4 7 6
White	4 7 6	4 7 6
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge*	—	—
„ „ Foundry	4 10 0 to 5 0 0	
(3) Northampton—		
Foundry No. 3	4 10 0	—
„ Forge	4 0 0 to 4 2 6	—
(3) Derbyshire—		
No. 3 Foundry	4 11 0	—
Forge	4 4 0 to 4 5 0	
(3) Lincolnshire—		
Basic	4 12 0	—
No. 3 Foundry	4 13 0	—
No. 4 Forge	4 11 0	—
(4) N.W. Coast—		
N. Lancs and Cum.—		
Hematite Mixed Nos.	5 10 0 (a) / 5 15 0 (b)	— / —

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	12 0 0	—
Best „	—	—
N.E. Coast—		
Crown Bars	12 0 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	12 0 0	—
Second Quality Bars	11 5 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best „	13 0 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	12 0 0 to 12 10 0	
Marked Bars (Staffs.)	14 10 0	—
Nut and Bolt Bars	10 15 0	—
Gas Tube Strip	12 10 0 to 12 12 6	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	13 0 0	—
Ship Plates, ½in. and up	10 0 0	—
Sections	9 15 0	—
Steel Sheets, 5/16in. to ½in.	12 10 0	—
Sheets (Gal. Cor. 24 B.G.)	—	18 17 6

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 15 0	—
Angles	9 5 0	—
Boiler Plates	13 0 0	—
Joists	9 10 0	—
Heavy Rails	9 10 0	—
Fish-plates	12 10 0	—
Channels	9 5 0	—
Hard Billets	10 5 0	—
Soft Billets	9 0 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 5 0†	—
Light „	9 0 0 to 9 10 0†	
Billets	8 0 0 to 11 0 0†	
Manchester—		
Bars (Round)	10 5 0 to 10 10 0	
„ (others)	10 0 0 to 10 2 6	
Hoops (Best)	15 5 0	15 0 0
„ (Soft Steel)	13 15 0	13 10 0
Plates	9 15 0 to 10 0 0	
„ (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	12 10 0	—
Bessemer Billets	13 0 0	—
Hard Basic	10 5 0	—
Intermediate Basic	10 0 0	—
Soft Basic	8 0 0	—
Hoops	12 10 0	—
Soft Wire Rods	11 10 0	—
Midlands—		
Small Rolled Bars	9 10 0 to 9 15 0	
Billets and Sheet-bars	7 15 0 to 8 5 0	
Gas Tube Strip	10 10 0	—
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	19 0 0 to 19 5 0	
Angles	9 10 0	—
Joists	9 10 0	—
Tees	10 10 0	—
Bridge and Tank Plates	10 0 0 to 10 5 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	23/1½ to 23/3
Block Tin (cash)	206 0 0
„ (three months)	202 5 0
Copper (cash)	60 7 6
„ (three months)	61 2 6
Spanish Lead (cash)	26 10 0
„ (three months)	25 12 6
Spelter (cash)	32 10 0
„ (three months)	32 2 6
Manchester—	
Copper, Best Selected Ingots	64 0 0
„ Electrolytic	65 0 0
„ Strong Sheets	92 0 0
„ Tubes (Basis price)	0 1 1½
Brass Tubes (Basis price)	0 0 11½
„ Condenser	0 1 2
Lead, English	27 10 0
„ Foreign	26 0 0

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/10 per lb.	
Ferro Tungsten	1/5½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 0 0	10/6
„ 6 p.c. to 8 p.c. „	£21 0 0	8/-
„ 8 p.c. to 10 p.c. „	£20 0 0	8/-
„ Specially Refined		
„ Max. 2 p.c. carbon	£50 0 0	18/-
„ „ 1 p.c. „	£60 0 0	21/-
„ „ 0.75 p.c. carbon	£70 0 0	22/6
„ carbon free	1/6 per lb.	
Metallic Chromium	4/3 per lb.	
Ferro Manganese (per ton)	£18 for home, £20 for export	
„ Silicon, 45 p.c. to 50 p.c.	£11 10 0 scale 5/- per unit	
„ „ 75 p.c.	£19 10 0 scale 6/- per unit	
„ Vanadium	18/- per lb.	
„ Molybdenum	9/- per lb.	
„ Titanium (carbon free)	1/1 per lb.	
Nickel (per ton)	£130	
Cobalt	11/6 per lb.	
Aluminium (per ton)	£82 to £100 (British Official.)	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	20/6
„ „ Ell	22/3
„ „ Splint	22/6 to 24/-
„ „ Trebles	24/-
„ „ Doubles	23/6
„ „ Singles	22/-
Ayrshire—	
(f.o.b. Ports)—Steam	20/6
„ „ Splint	22/6
„ „ Trebles	24/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	20/6 to 23/-
Screened Navigation	27/6
Trebles	26/9
Doubles	24/-
Singles	22/6
Lothians—	
(f.o.b. Leith)—Best Steam	22/6
Secondary Steam	21/3
Trebles	25/6
Doubles	24/6
Singles	22/9

ENGLAND.

(8) N.W. Coast—	
Steams	30/-
Household	46/8 to 57/6
Coke	43/6
Northumberland—	
Best Steams	24/6 to 25/-
Second Steams	22/6 to 23/-
Steam Smalls	15/- to 16/6
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	24/- to 25/-
Second	22/6 to 23/6
Household	25/- to 28/-
Foundry Coke	50/- to 52/6

Sheffield	Inland.	
Best Hand-picked Branch	29/6 to 31/-	—
Barnsley Best Silkstone	26/6 to 28/-	—
Derbyshire Best Brights	25/- to 27/-	—
„ „ House	22/6 to 23/6	—
„ „ Large Nuts	20/- to 21/6	—
„ „ Small „	15/- to 16/-	—
Yorkshire Hards	21/- to 23/-	—
Derbyshire „	20/- to 22/-	—
Rough Slacks	11/6 to 13/6	—
Nutty „	10/- to 12/-	—
Smalls	7/- to 9/-	—
Blast-furnace Coke (Inland)	34/- to 35/-	
„ (Export)	f.o.b. 40/- to 42/-	

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	27/6 to 28/6
Second „ „	26/6 to 27/-
Best Dry Large	28/- to 28/6
Ordinary Dry Large	26/- to 27/-
Best Black Vein Large	27/- to 27/6
Western Valley „	26/- to 27/-
Best Eastern Valley Large	24/6 to 25/6
Ordinary „ „	23/6 to 24/6
Best Steam Smalls	18/- to 19/-
Ordinary „	16/- to 18/-
Washed Nuts	27/6 to 30/-
No. 3 Rhondda Large	28/- to 29/-
„ „ Smalls	24/- to 25/-
No. 2 „ Large	23/- to 24/-
„ „ Through	18/6 to 20/6
„ „ Smalls	15/- to 16/-
Coke (export)	42/6 to 50/-
Patent Fuel	29/- to 32/-
Pitwood (ex ship)	26/- to 27/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	47/6 to 50/-
Seconds	35/- to 40/-
Red Vein	32/6 to 35/-
Machine-made Cobbles	60/- to 62/6
Nuts	60/- to 62/6
Beans	45/- to 47/6
Peas	28/- to 30/-
Breaker Duff	12/6 to 13/-
Rubbly Culm	15/- to 16/-
Steam Coals:	
Large	24/- to 25/-
Seconds	22/- to 23/-
Smalls	14/- to 16/-
Cargo Through	19/- to 21/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow.

(8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

* Quotations extremely high and nominal. † Latest quotations available. (a) Delivered Sheffield or Glasgow. (b) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Motor Cars.

The success of the annual Salon de l'Automobile lies not so much in any conspicuous evidence of progress in motor engineering as in the remarkably fine presentation of the vehicles, in which everything has been done to satisfy the requirements of users as regards appearance and comfort. If the bodies follow certain lines which custom has imposed upon builders, the chassis are generally better sprung, and the use of self-starters and brakes on all four wheels contributes largely to the greater comfort and safety of motoring. It is difficult to imagine what else can be done to provide additional conveniences to the motor car user. At previous shows all these refinements were confined to the larger and more expensive vehicles, and the light car was regarded as a cheap substitute from which all but the most indispensable accessories were excluded; but the past year or two has brought about so vast a change in the industry that the light car has dethroned the big vehicle, the result being that engineering skill has been centred in the perfection of the small car, which, with the additional refinements, has notably increased in price. Owing to the high cost of petrol, the question of running costs has become of primary importance, and the 10 horse-power car of to-day has brought down the expenses to as low as can be expected, at the same time that a chassis with an ample four-seated body will travel as fast, and with almost as much comfort, as the bigger vehicle which consumes much more fuel and costs more for tires. Consequently, while not neglecting the big cars, nearly every maker is turning out small vehicles with engines of 10 or 12 horse-power, and there is no doubt that the departure will give an enormous impulse to the development which has been taking place in the industry during the past year. So far as the chassis are concerned, there is very little modification in the general design, which continues to take the form of the unit system with the gear-box forming an extension of the crank case; but a notable exception is the new Renault chassis, which has returned to the old arrangement of separating the engine from the gear-box—an arrangement which certainly offers the advantage of accessibility, while at the same time the robust construction and the method of erection adopted on the Renault vehicle preclude any loss of efficiency through want of alignment.

Engines and Transmissions.

In nearly all the innovations carried out in motor car design, we see a return to old ideas which have had to pass through the crucible of experience before they could be adopted by the industry generally. The hemispherical combustion chamber with overhead valves has always, of course, been recognised as giving the greatest efficiency on account of the concentration of the gas mixture and the ignition in the mass; but the system has been slow of adoption on touring cars, principally on account of the need of a silent engine, and a great deal of refinement has been necessary to eliminate the noise of the valves actuated by an overhead lay-shaft. The enclosure of the entire valve gear has helped to ensure sufficient silence, at the same time that it has given a remarkably neat and clean appearance to the engine. Even the circulating pump now forms practically an integral part of the engine, instead of being geared down outside as formerly. The four-cylinder engine with the cylinders in one casting is still paramount, but there continues to be about the same proportion of six and eight cylinders in line for the expensive cars. Self-starters have become general, and it would probably be difficult to sell vehicles without them. There is a curious lack of new departures in engines. The attempts at introducing air-cooled engines for light cars have so far failed on account of the great variation of climatic conditions in this country and the mountainous character of many regions; but one maker has produced a successful engine with regulated air cooling by means of a turbine in a sort of cowl which distributes the air current all round the engine, and therefore ensures a uniform cooling of the cylinders. On the Ariès stand there is a 10 horse-power engine with ribs covering the upper part of the crank chamber. On the whole, there is no departure from what has come to be regarded as a standard design, and all improvements have been made in the direction of refinements and adjustments with the idea of giving the greatest flexibility and the lowest fuel consumption. On account partly of the unit system necessitating compactness, the single plate clutch is largely employed, but many firms still adhere to the old cone clutch with spring and other devices for ensuring a gradual engagement. There is very little that is new to be observed in gears, and while on most of the small cars the variable speed and brake levers are placed centrally on the box, on the bigger vehicles they are usually at the side. The fitting of brakes on the front wheels is becoming general. This equipment necessitates very careful design and adjustment, for the blocking of the front wheels without adequate braking effect on the rear wheels is liable to have disastrous results; but properly designed brakes on the four wheels are almost indispensable for safety on the modern fast cars. One firm exhibited a compressed air control of the brakes which may offer possibilities of development. In a general way, the motor industry, having done all it can to produce a well-designed and efficient vehicle, is giving more attention to the education of the public, which is now so thoroughly conversant with the motor car that it needs something more than a mere display of chassis and vehicles.

New Fuels.

If the cost of petrol in this country is high, the quality is by no means satisfactory to users, who really never know what they are employing in their engines, and with the admixture of alcohol, the problem of getting the best results out of the fuel is a very complicated one. This has put a check upon the short-stroke engine, and the problem of economy can only be solved by carburetter devices and adjustments. The object of the engine designer is to realise very high piston speeds. He has done this with remarkable success, but he is still a slave of the fuel problem.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

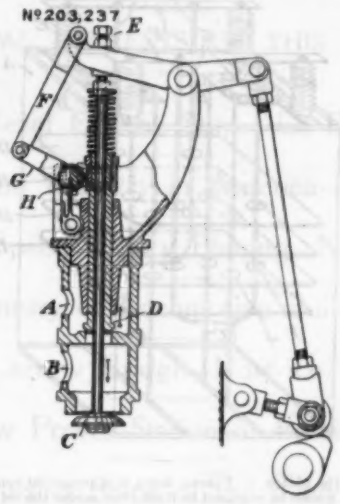
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

INTERNAL COMBUSTION ENGINES.

203,237. November 15th, 1922.—Inlet Valves, J. Knight and Hale, Limited, Vigour Ironworks, Denton, Lancs., and J. E. Whitaker.

This is a combined fuel and air valve. The fuel enters at A and the air at B, while the stem of the air valve C passes through that of the fuel valve D. The air valve is opened, downwards,

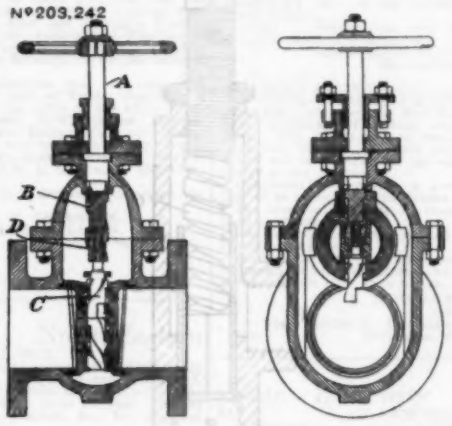


by the adjustable tappet E on a normal rocking lever. The fuel valve is opened upwards, by the link F and rocking lever G. This lever has, at its fulcrum, a "hit-and-miss" knife edge H, controlled by the governor, so arranged that when the knife edge misses, the lever G rocks freely without opening the valve D, which is kept closed by the spring shown.—*September 6th*, 1923.

TRANSMISSION OF POWER.

203,242. November 27th, 1922.—Sluice Valves, V. Autier, 103, Rue de l'Est Fives-Lille, Nord, France.

In this valve the movement of the sluice is slow during the time when, on opening, it is being lifted off its seating, and the speed is greatly increased for the remainder of the stroke. The action is the reverse on closing. The spindle A is fixed longitudinally, and is provided with a steep-pitch screw thread B.

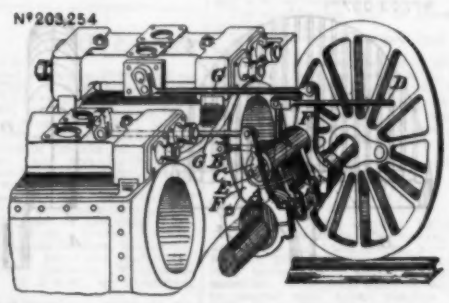


It is extended downward by a correspondingly threaded piece C, and the two are connected together by a slow-pitch thread D. The valve disc is threaded to suit the steep-pitch screw. In the process of opening, the extension C first screws up into A slowly, and when the gap between these two parts has been closed up, the disc rises rapidly on the steep-pitch screw.—*September 6th*, 1923.

LOCOMOTIVES.

203,254. December 19th, 1922.—Reversing Gear, H. Lenz, 86, Charlottenstrasse, Berlin, Germany.

The inventor says that with this valve gear the effect of the

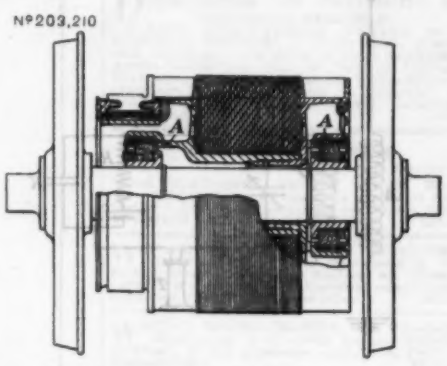


rise and fall of the driving axle, with reference to the frame, on the valve movement, is reduced to a minimum. A bracket A is mounted on the main axle and is held by the stay B. Within it there is a drum C, which can be rocked by the link D leading to the cab. The ends of the drum C are provided with inclined slots E in which studs fixed in the excentric rods F can slide. A fore-and-aft motion is thus given to the top of the excentric rods, and is transmitted to the valves by the rods G.—*September 6th*, 1923.

TRAMWAYS AND RAILWAYS.

203,210. October 6th, 1922.—Improvements in and relating to Electric Motors, The British Thomson-Houston Company, Limited, of Crown House, Aldwych, London, W.C. 2.

This invention relates to railway motors, and more particularly to the mounting of such motors. When the armature of an electric motor is heavy, and is mounted on and directly supported by the axle of an electric locomotive, the deadweight on the

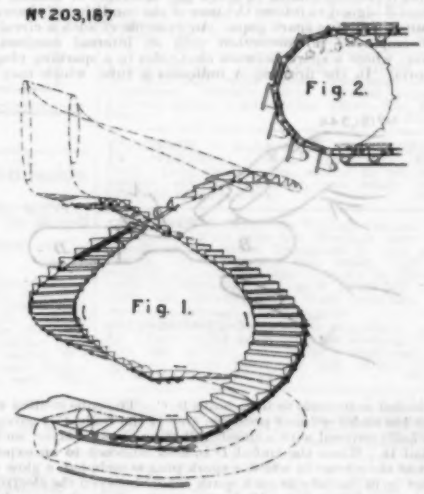


axle may be excessive, and this deadweight will deliver destructive blows to the tracks on which the locomotive runs. The object of this invention is to prevent the delivery of such blows on the tracks. The armature is supported on and drives the shaft through the medium of members A made of non-metallic cushioning material, such as rubber, which are fastened both to the hub and to the shaft. The members A are formed in the shape of rings.—*September 6th*, 1923.

CRANES AND CONVEYORS.

203,187. September 2nd, 1922.—Moving Stairways, H. Fraser, 34, Hill-street, Garnethill, Glasgow.

The inventor proposes to construct a moving staircase as a double spiral, as shown in the perspective view, Fig. 1, one turn

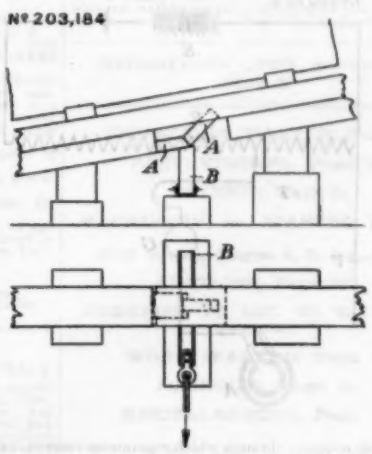


being used for ascent and the other for descent. Details of the links and treads are given. The treads are reversed, as they go over the top and bottom drums, as shown in Fig. 2.—*September 6th*, 1923.

SHIPS AND BOATS.

203,184. August 30th, 1922.—Ship's Launching Gear, D. C. Endert, jun., Mathenesserlaan 276, Rotterdam, Holland.

This trip gear for launching ships from the ways merely

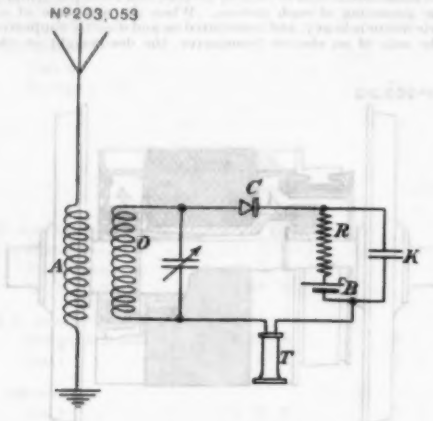


consists of a toggle A A supported on a prop B. It will be seen that if the prop B is withdrawn sideways, the toggle will collapse and the sliding ways will be freed.—*September 6th*, 1923.

TELEGRAPHS AND TELEPHONES.

203,053. May 31st, 1922.—Improvements in Wireless Telegraph Receiving Circuits, Henry Joseph Round, of 9, Woodberry-crescent, Muswell Hill, London, N.

This invention relates to wireless receiving circuits of the type in which a crystal, such as carborundum, requiring an auxiliary potential, is employed as the detector. A high resistance is employed in series with a cell or cells in place of the potentiometer, which has hitherto been employed, and the resistance and the cell are shunted by a condenser. The aerial circuit A is coupled to an oscillatory circuit O, which is connected to a

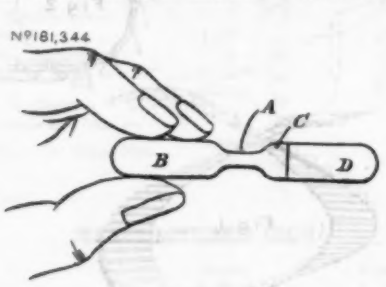


carborundum crystal C and a telephone T, between which there are a high resistance R and a dry cell or cells B. The resistance may be, say, 100,000 ohms or more. K is a condenser shunting the resistance and cell for allowing high and low-frequency oscillations to pass with low impedance. This arrangement has the advantage that, owing to the resistance, the current from the cell is very small, and therefore the life of the cell is considerably lengthened, and, in addition to this, it is found that practically all crystals of the same composition are in adjustment with the same resistance, so that no adjustments are necessary when a new crystal is inserted.—*August 31st*, 1923.

MISCELLANEOUS.

181,344. May 29th, 1922.—Spark Gap Detector, *Air Reduction Company*, 342, *Madison-avenue, Manhattan, City of New York*.

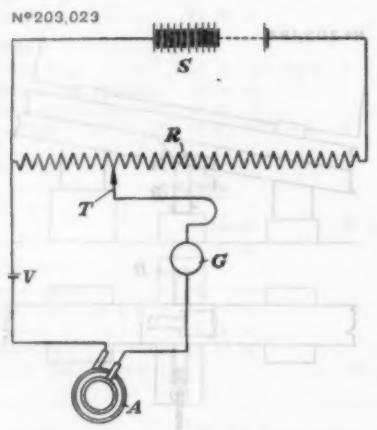
This invention relates to spark gap detectors or testers, *i.e.*, devices designed to inform the user of the condition of electrical circuits, including spark gaps. An example of such a circuit is that employed in connection with an internal combustion engine, where a spark between electrodes in a sparking plug is essential. In the drawing A indicates a tube, which may be



expanded at its ends to form bulbs B, C. The tube is filled with neon gas under reduced pressure. One of the bulbs C is partially or wholly covered with a closely adhering metallic layer, such as tinfoil D. When the tinfoil D is held adjacent to an exposed part of the circuit in which a spark plug *is* included, a glow will be set up in the tube as each spark occurs between the electrodes of the sparking plug. If, however, the electrodes are short-circuited by the deposition of carbon, no glow will be noted in the tube.—*August 29th*, 1923.

203,023. May 24th, 1922.—Improved Method of and Means for Establishing Electrical Connection between Movable Contacts, Eversheds and Vignoles, Limited, and John Cuthbert Needham, both of Acton-lane Works, Chiswick.

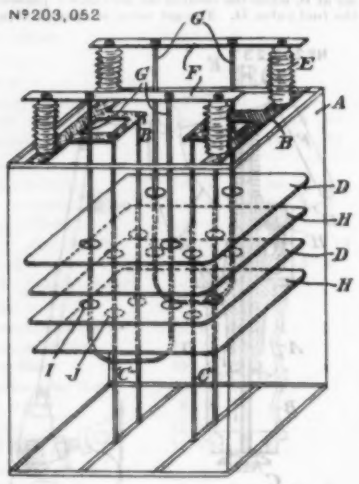
This invention relates to an improved method of and means for establishing and maintaining electrical connection between



movable contacts through which continuous current is intended to pass. The invention is applicable to movable contacts, such as are employed in switches, potentiometers, relays, &c. An alternating electromotive force is introduced into the circuit from a separate source in the manner shown in the diagram. R represents the resistance coil of a potentiometer, V a standard cell, S the source of supply for the resistance coil, T is a sliding contactor, and G a galvanometer. Into the galvanometer circuit a source of alternating electromotive force is introduced. For the purpose of illustration, the source has been shown diagrammatically as an alternator A with slip rings, but obviously it might be an inductor type machine in which moving contacts would not be required, or the secondary windings of an induction coil energised by continuous current.—*August 24th*, 1923.

203,052. May 31st, 1922.—Improvements in Electrical Condensers, William Theodore Ditcham, of Middleton House, Victoria-road, Colchester, Essex.

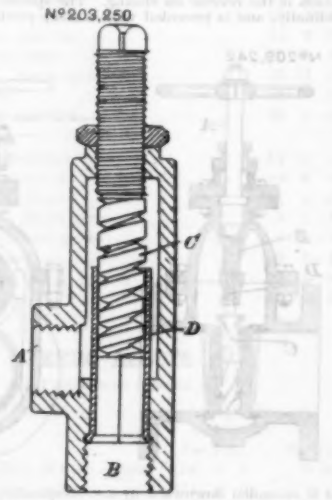
This invention relates to the construction of an electrical condenser with a liquid dielectric suitable for use with high-frequency high-voltage currents, such as are employed in radio telegraph apparatus. If a condenser consisting of two sets of plates and separating insulators of such material as glass or porcelain, is immersed in a liquid dielectric, such as oil, and subjected to a high-frequency voltage, it is found that the insulators, unless of dimensions out of all proportion to the distance



between the plates, will break down at a potential considerably less than would be required to flash over across the oil dielectric between the plates. According to this invention, a condenser is constructed, so that while the two sets of electrodes are immersed in the liquid dielectric, the insulators separating one set from the other are in the air outside the liquid. Across the top of the container A there are two metal bars B, from which rods C depend and carry plates D. On the bars B insulators E rest, and support bars F, from which rods G depend and carry plates H. Holes I and J are cut in the plates D H to provide openings for the rods G C.—*August 31st*, 1923.

203,250. December 11th, 1922.—Steam Traps, O. T. Clorius, 5, Hauschvej, Frederiksberg, Kopenhagen.

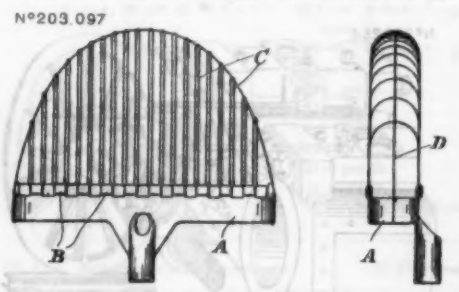
In this trap the inlet is at A and the outlet at B. The plug C has "crosswise" grooves D and fits tightly in the sleeve.



It is claimed that the grooves will provide a passage for the water of condensation, but will check the escape of steam. Adjustments can be made by screwing the plug into or out of the casing.—*September 6th*, 1923.

203,097. January 22nd, 1922.—Improvements in Thermionic Valves, William Richard Bullimore, of Aberdeen Works, Aberdeen-lane, Highbury-grove, London, N. 5.

This invention relates to a special form of grid for thermionic



valves, the object being to construct a grid that is rigid and which is held in fixed relationship to the filament and anode. A metal collar A is formed over a mandrel, and the collar is formed with a castellated edging which is bent over to form hooks B, under which the grid wire is laced to form a number of loops C, which conform as closely as possible with the contour of a semi-circular filament. One end of the wire is first secured beneath one of the hooks B, and the wire is afterwards anchored at alternate sides of the collar A until the required number of loops has been formed. When the formation of the loops is complete, the hooks B are closed against the body of the collar A to prevent displacement of any part of the wire. The loops C may be stiffened by bracing them with one or more wires D.—*September 6th*, 1923.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Paper, "The Never-Stop Railway" (slides), by Mr. W. Yorath Lewis. 7.30 p.m.

Manchester Association of Engineers.—Memorial Hall, Albert-square, Manchester. Inaugural address by the president, Mr. Cecil Bentham. 7 p.m.

SATURDAY, OCTOBER 13TH.

Junior Institution of Engineers.—Visit to the works of the Gas Light and Coke Company, at Beckton. 2 p.m.

Keighley Association of Engineers.—Assembly Room, Cycling Club, Cavendish-street, Keighley. "Hardness and its Measurements," by Professor G. F. Charnock. 6.30 p.m.

North of England Institute of Mining and Mechanical Engineers.—Newcastle-upon-Tyne. Papers: "The Permian Formation in East Durham," by Mr. W. O. Wood; and "Vertical and Lateral Variations in the Composition of Bituminous Coal Seams," by Professor Henry Briggs. 2 p.m.

MONDAY, OCTOBER 15TH.

Institute of Marine Engineers.—85-88, The Minories, E. 1. Extraordinary general meeting for confirmation of alterations to by-laws. 6.30 p.m.

Institution of Automobile Engineers: Scottish Centre.—Royal Technical College, Glasgow. Presidential address, "Automobile Engineering as a Profession," by Mr. H. G. Burford. 7.30 p.m.

TUESDAY, OCTOBER 16TH.

Institution of Automobile Engineers: Wolverhampton Centre.—Star and Garter Hotel, Wolverhampton. Presidential address, "Automobile Engineering as a Profession," by Mr. H. G. Burford. 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland.—Rankine Hall, 39, Elmbank-crescent, Glasgow. Presidential address by Mr. J. Howden Hume. Paper, "Losses in the Component Parts of a Three-stage Turbine Pump," by Dr. W. Blackadder. 7.30 p.m.

WEDNESDAY, OCTOBER 17TH.

Institution of Production Engineers.—The Engineers' Club, Coventry-street, W. 1. Presidential address by Mr. J. D. Scaife. 7.30 p.m.

Royal Meteorological Society.—49, Cromwell-road, South Kensington, S.W. 7. Discussion on paper, "Towards a Basis of Meteorological Theory: Thirty-nine Articles of Condition for the Middle Atmosphere," by Sir Napier Shaw, F.R.S., and Captain D. Brunt. 5 p.m.

Society of Glass Technology.—The University, St. George's-square, Sheffield. Papers: "The Effect of Titania on the Properties of Glass," by Mr. A. R. Sheen and Professor W. E. S. Turner; "The Estimation of Selenium in Glass," by Mr. A. Cousen. 3 p.m.

THURSDAY, OCTOBER 18TH.

Institution of Mining and Metallurgy.—The Geological Society's Rooms, Burlington House, Piccadilly, W. 1. Papers: "The Concentration of Gold-copper Ores by Froth Flotation at Tul Mi Chung, the Seoul Mining Company, Korea," by Mr. R. J. Lemmon; "Sicilian Practice in Sulphur Extraction," by Mr. C. L. Sagui. 5.30 p.m.

Royal Aeronautical Society.—Royal Society of Arts, 18, John-street, Adelphi, W.C. 2. "The Manœuvres of Inverted Flight," by Squadron-Leader R. M. Hill. 5.30 p.m.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, London, W.C. 2. Presidential address by Dr. Alexander Russell. 6 p.m.

FRIDAY, OCTOBER 19TH.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Presidential address by Sir John Dewrance. 6 p.m.

Institution of Railway Signal Engineers.—Hotel Great Central, W. 1. Annual dinner. 6.30 for 7 p.m.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "The Gas Boiler (or Circulator) and its Application," by Mr. F. W. Dye. 7.30 p.m.

MONDAY, OCTOBER 22ND.

Institute of Physics.—Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Lecture, "The Physicist in the Textile Industries," by Dr. A. E. Oxley. 5.30 p.m.

Institution of Automobile Engineers: Birmingham Centre.—Chamber of Commerce, New-street, Birmingham. Presidential address, "Automobile Engineering as a Profession," by Mr. H. G. Burford. 6.45 p.m.

Institution of Mechanical Engineers: Graduates' Section, London.—Storey's-gate, S.W. 1. "Four-wheeled Brakes for British Light Cars," by Mr. J. Harrison. 7 p.m.

FRIDAY, OCTOBER 26TH.

Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Crystals for Wireless Reception," by Mr. A. V. Ballhatchet. 7.30 p.m.

Newcomen Society.—Prince Henry's Room, 17, Fleet-street, E.C. 4. Presidential address, "The Value of the History of Technology," by Mr. L. St. L. Pendred. 5.30 p.m.